IRIS27
Plenary Papers

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Editors´ Comments

Per Flensburg and Carina Ihlström (Eds.)

1. Introduction

1.1 Historical background

The beautiful Scandinavian maiden, IRIS, who soon will reach the age of 27 has decided to marry the American guy AIS. This leads to new challenges; it is time to move on, it is time to build a joint future. The original idea of the IRIS conference was to discuss, comment upon, and improve papers. This was, and still is, an outlet for doctoral students to publish their first research paper. Today, there is a debate within the IRIS community, suggesting that the quality of the papers should be improved, without destroying the typical IRIS atmosphere characterized by support, collaboration, enthusiasm and encouragement. This year, we will try to achieve this by having plenary sessions where twelve selected papers will be presented and then printed in one volume available at the conference. This is the volume.

IRIS belongs to the area called "*information systems*" as it was first formulated in the Manchester colloquium 20 years ago. However, in the IRIS community it started earlier, already 1978! At that time, it was called "the Scandinavian Approach to Systems Development". We learned that the users influence was important and we investigated many different ways for achieving this. In the end of the 90s we knew how to. Now, in the new millennium, when we face new challenges it is time to move on. How can we use our knowledge of user control and influence in the new networked and mobile society we see approaching? How will Internet and mobility influence the traditional focus on the business process within a single company? Can we use ideas form other sciences to move our own further?

IRIS27 is a working conference based upon accepted papers, panel or workshop proposals contributing to the community of IS research. Acceptance of a paper for the conference requires that the paper be reviewed as appropriate for the conference, and second that the author(s) of the paper(s) conduct quality review(s) of other submitted paper(s). An important and much appreciated objective of the conference is to be a forum for young researchers, including research students. During IRIS27, work will be done intensively within a small group where there are people with various levels of expertise but who focus on similar issues in the broader IS field.

1.2 Conference theme

When we first come to life, we start to develop our learning skills as a way to survive. We learn how to walk, how to speak, and how to read. We start school and learn math, history, and English; eventually we move on to higher education. At the university, we learn systems design, systems analysis, programming, and many other useful things. However, when we have learned the basic tenets of our discipline, we are capable of seeing patterns, visualizing models, and refining theories. In this reflective process, these original ideas evolve as we apply them to solve problems, resulting in new knowledge. Sometimes we know the appropriate solution by intuition. To move further, we must challenge our underlying assumptions, thus stepping forward to meet new challenges, problems, and ideas. We learn, we know, and we move. As we go along, many interesting questions arise: What do we learn, what do we know, and in which direction do we move? IT, of course! Hence, the theme of the 27th IRIS will be: Learn IT, Know IT, Move IT.

1.3 Submission and review process

The reviewing process of the IRIS conference serves two purposes: First, it provides a means for evaluating papers with respect to their inclusion in the conference proceedings; and second, it provides substantive feedback to authors to assist them in improving their work. The reviewing process is double-blind in the sense that the reviewers are anonymous to the authors and the authors are anonymous to the reviewers. Three reviewers including at least one senior researcher will review all papers. Each author is expected to review, at least, three papers.

1.4 Evaluation criteria

We promote original, outstanding, creative and exciting papers. Each submission will be evaluated according to the following criteria (in priority order):

1) Originality
2) Quality of argumentation and evidence
3) Readability
4) Contribution to research
5) Contribution to practice
6) Relevance to the conference theme

Additional criteria that can influence the selection of a paper for plenary presentation:

- *Theories from different areas such as economy, sociology, philosophy etc. applied in an innovative way*
- *New innovative areas*
- *Innovative use of old theory*
- *Relevance of research methodology*

2. The result of the review process

The review criteria were organised in three sections. First the reviewer was asked to provide a numerical evaluation according to the following criteria:

- *Originality of research 1(Poor) - 5(Excellent)*
- *Selection and use of research method 1(Poor) -5(Excellent)*
- *Quality of argumentation and evidence 1(Poor) - 5(Excellent)*
- *Readability of paper 1(Poor) - 5(Excellent)*
- *Contribution to research in this field 1(Poor) - 5(Excellent)*
- *Contribution to practice 1(Poor) - 5(Excellent)*
- *Relevance to the conference theme 1(Poor) - 5(Excellent)*
- *Overall Evaluation 1(Poor) - 5(Excellent)*
- *Your familiarity of the topic 1(Moderate) -5(High)*

Second the reviewer was asked to provide some qualitative evaluations according to the following questions:

- *What do you see as the main ideas of the paper?*
- *What are the strengths of the paper?*
- *What are the weaknesses of the paper?*
- *Suggestions for improvements*?

Finally, the reviewer was asked to provide some recommendations:

- *Recommend considering for publication in SJIS?*
- *Recommend considering for printed & plenary paper?*
- *Comment for the Author(s) & Review Board*
- *Recommendation :*

The first two recommendations was yes or no recommendations, the comments were free text and the final recommendation was a choice between “rejected”, “accept with revision” and “accept as is”. The overwhelming part of the recommendations was “accept with revision”.

It turned out that the selection of the 12 best papers was rather easy since it turned out that 12 papers had recommendations for plenary presentation from three reviewers or more.

As organisers of the conference we are very pleased to present this selection of the best papers from IRIS27 in Falkenberg, Sweden. We hope we have created a new trend in IRIS.

Per & Carina

Improve by Improving the Improvers

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***Abstract**: The business environment for software organizations is constantly changing depending on customer requirements, business opportunities and threats, competitor's product portfolio, new development techniques and tools, and employee rotation due to organizational growth or lay-offs. A challenge for a software organization is to manage to feed the people in the organization with necessary know-how that align with this constantly changing business environment. This research presents how a software product development unit within the telecom company Ericsson AB in Gothenburg, Sweden, improved the know-how of its Software Process Improvement (SPI) change agents to improve the SPI success rate. The study presents detailed data from a one-year action learning effort for twelve SPI change agents and shows the implications it had on the SPI success rate in the organization. The lessons learned indicate a number of beneficial consequences for the organization and the SPI success rate. The lessons learned are discussed in relation to the established SPI literature and assessed through the single- and double-loop learning theory.*

***Keywords**: Software Process Improvements, Action Learning, Single-Loop Learning, Double-Loop Learning, Return of Investment.*

1. Introduction

SPI has been adopted by many organizations as a strategy to enhance their capability to deliver qualitative software (Humphrey, 1989; Grady, 1997; Mathiassen et. al, 2002). Most software organizations do, however, struggle with finding a good balance in the SPI work between beneficial investments and return of these investments. Far too many reports show how SPI efforts fail (Bach, 1995; Bollinger and McGowan, 1991; Börjesson and Mathiassen, 2003; Fayad and Laitinen, 1997; Humphrey and Curtis, 1991) and the indicated reasons are many, such as lack of commitment and management attention (Abrahamsson, 2000; Abrahamsson, 2001), inappropriate change management and reactions to change (Weinberg, 1997), knowledge barriers (Attwell, 1992) and low

deployment focus (Fichman and Kemerer, 1997). Also, the environment, in which organizations act, is far from stable. Software organizations constantly need to react on market dynamics, new customer requirements, technological innovations, and mergers between software companies. The degree and pace of the organizational dynamics have increased over the past years as indicated by the notions of fast-moving software organizations (Holmberg and Mathiassen, 2001) and radical IT-based innovations (Lyytinen and Rose, 2003). Agility, the ability to innovate and improve in parallel (Dove, 2001), has during the last decade been added to the list of challenges to assure successful SPI.

On a practical level the key issues are, however, almost always a matter of knowledge about *how* to assure commitment, *how* to involve developers, *how* to pay attention to change reactions, *how* to interpret and use models, and *how* to become an agile organization. One important factor to assure successful SPI initiatives is therefore to secure that the SPI change agents possess that right know-how to effectively drive the SPI initiatives. The telecom company Ericsson AB in Gothenburg, Sweden (a company with over 20 years of experience developing packet data solutions for the international market), has recognised gaps in relevant "*know-how*" as a major threat to successful SPI.

To manage and overcome gaps in know-how an action learning approach (Marquardt and Revans, 1999) was taken to create the learning and improve the know-how of twelve SPI change agents within the SPI unit in the company. The main question raised was: 'how can one improve SPI change agents' know-how to improve software organizations'? The theme of this research is to explore the SPI unit's action learning initiative and the results of it and discuss it in relation to established SPI literature (Humphrey, 1989; McFeeley, 1996; Grady, 1997; Fichman and Kemerer, 1997; Mathiassen et. al., 2001). The study is based on action research and learning over a one-year period. The initiative aimed to improve the know-how of the change agents in the SPI unit and by that, improve the SPI success rate. SPI success is ideally measured in differences in quality and productivity between old and new practices. This is however difficult to measure without comparable data from longitudinal studies. In this study, SPI success is therefore, defined and measured by the difference in perception between old and new practices by both individuals taking part in the action learning initiative and individuals affected by SPI.

Argyris and Schön's (1996) theories of single- and double-loop learning are used to assess the degree of learning. Lessons learned from the study show an increased SPI success rate as a result of improving the SPI change agents' know-how. However, the SPI unit did not perform double-loop learning in the sense that the SPI change agents' governing variables changed. The change did however, address and debate the governing variables and affect the change agents' action strategies.

The argument is presented as follows. Section 2 presents the theoretical context for SPI competences, action learning and organizational learning. Section 3 describes the research approach. Section 4 presents data from the SPI unit's

action learning initiative according to Susman and Evered's (1978) cyclical action research approach. Section 4 also discusses the contributions of the research and conclusions and findings are presented in chapter 5.

2. Theoretical Context

This section is presented in three different parts. First, section 2.1 discusses the needed competences for SPI change agents. Second, section 2.2, discusses actions learning. Third and last part, section 2.3 discusses organizational learning and explains the single- and double-loop learning theory (Argyris and Schön, 1996) and how this theory is used to understand and assess the action learning initiative.

2.1 SPI Competences

An SPI change agent, as defined by Humphrey (1989), needs to be knowledgeable in SPI, but also in other related areas. Change management, diffusion of IT, organizational learning, knowledge management, and agility is required competences to understand how to define and deploy new or changed software processes, to manage reactions to change, to understand what knowledge we work with, and to understand how we can learn from others in the best possible way.

Since Watts Humphrey's 'Managing the Software Process' (1989), a lot of research has been focused towards SPI. Known SPI models are the Capability Maturity Model – CMM (Paulk et. al., 1995), the IDEAL Model (McFelley, 1996) and the Plan-Do-Act-Check (Grady, 1997). CMM presents a stepwise approach to SPI, while the IDEAL model and Plan-Do-Act-Check present a cyclic approach to SPI.

Weinberg (1997) describes in the Satir Change model how people react to changes. Rogers (2003) discusses how different people tend to take on different roles, such as early or late adopters and early and late majority, when exposed to changes. This knowledge is further developed by Moore (2002), who emphasizes the chasm between early adopters and early majority. Fichman and Kemerer (1997) have shown how acquisition of certain IT technologies differs from its deployment. Fichman and Kemerer call this the assimilation gap. Models have been introduced to close this gap like Pries-Heje and Tryde's (2001) workshop model for diffusion of a new software technology. This model consists of six steps to characterise the implementation project, decide implementation roles, determine the whole product, decide implementation strategy, determine implementation risks, and outline the implementation plan. This model has also been successfully adapted at Volvo AB in Gothenburg Sweden (Andersson and Nilsson, 2002). Kautz et. al (2001) discuss diffusion of IT from a change agent's perspective (called process agents by

Kautz et. al). A change agent can work in combinations of four different perspectives (technical expert, facilitating participant, political agent, and individual therapist) and by that contribute more to the SPI result. SPI models, change management models, the assimilation gap, diffusion models, and change agent roles all imply important know-how for SPI change agents to execute effective SPI work.

2.2 Action Learning

SPI change agents can benefit from reflecting-in-action (Schön, 1983) to continuously learn and improve professionally. When critically reflecting over an action situation and learning from it, it is called action learning (Marquardt and Revans, 1999). Action learning is about "learning" and "doing" in parallel. Action learning can be defined as a process in which a group of people come together more or less regularly to help each other to learn from their experience. Action learning provides for instance an SPI change agent the possibility to discuss whether negative reactions to a change initiative reflect faulty analyses or defensive routines (Argyris and Schön, 1996) as a result of the change itself.

The principle of action learning explicitly aims to improve the performance and learning of both individuals and organizations (Ballantyne *et al.* 1995). Ballantyne et. al. also argue that action learning confronts reality rather than studying a hypothetical situation, it is primarily work-based rather than classroom-based and it is group oriented and aims at transforming both individuals and organizations. Action learning has been successfully adopted to the IT discipline (Ruohonen, 1990).

Action research is a process by which change and understanding can be pursued at the same time. It is cyclic, with action and critical reflection taking place in turn. The reflection is used to review the previous action and plan the next one (Susman and Evered, 1978). Action research is a method that attempts to link theory and practice, thinking and doing, achieving both practical and research objectives (Susman, 1983). Galliers (1992) describes action research as an approach that allows us to create new theoretical knowledge in addition to something that has practical value for the organization under research.

Action learning and action research are strongly related forms of reflecting-in-action. Successful action learning requires an action situation to reflect over, a group of people willing to reflect over it and time to pursue the critical reflecting to further learn and understand.

2.3 Organization Learning

Argyris and Schön (1996) argue that individuals are centrally important to organizational learning, as it is their thinking and acting that influence the acquisition of capability for productive learning at the organizational level.

Organizational learning occurs when individuals within an organization experience a problematic situation and inquire into it on the organization's behalf. Argyris and Schön explain the difference between espoused theories and theories-in-use as the difference between theories as they are understood and as they are actually performed in action. Learning that results in a change in action strategies and assumptions of espoused theories, is called single-loop learning. Learning that results in a change in the governing variables, action strategies and assumptions of theories-in-use, is called double-loop learning. The main difference between single- and double-loop learning is whether the changed action strategy is a result of changed governing variables or just a result of new instruments used that made the change occur. Double-loop learning can be carried out both on the individual and organizational level. Figure 1 visualizes the single- and double-loop learning theory.

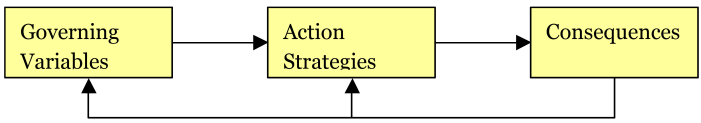

Figure 1. Single- and Double-Loop Learning (Argyris and Schön, 1996)

Organization learning is a dynamic process (Crossan et. al, 1999) where the individual, the group and the organization have to assimilate new learning and exploit learning already made. The delicate tension between assimilation and exploitation has to be well balanced so that learning takes place on an organizational level and not only on an individual or group level. Another complicating factor is that there is a gap between the ways people actually work and the ways organizations describe the work (Brown and Duguid, 1991). This gap corresponds to the differences between theories-in-use and espoused theories. An SPI change agent must carefully consider these differences to successfully diffuse new software processes to practice. The fact that the degree and pace of the dynamics have increased over the past years (Holmberg and Mathiassen, 2001; Lyytinen and Rose, 2003) makes it even more important to assure the right know-how to produce good results.

The 'single- and double-loop learning' theory (Argyris and Schön, 1996) can be used to both understand and assess a particular organization's learning initiatives. Figure 1 shows how the consequences are dependent on action strategies, which are dependent on governing variables. Through evaluating how the governing variables were addressed and the effect these had on the SPI success rate, it is possible to assess the value of the action learning approach adopted at Ericsson.

3. Research Approach

Our strategy to improve the SPI success rate at Ericsson through improving the change agent's know-how was based on an action learning approach.

The initiative aimed to improve know-how by extending the time for critically reflecting over an action situation and by providing the SPI change agents with conceptual lenses for this reflection.

The initiative was organized as a part of a collaborative practice study (Mathiassen, 2002) carried out at one of Ericsson's system development units. The overall purpose of the research was two fold -to improve SPI practices at Ericsson while at the same time contributing to the body of knowledge of SPI and organizational learning. The author has been working in and been responsible for the initiative. The potential bias and subjectivity is handled through discussion and interviews with engineers within Ericsson. Colleagues to the author from academia have been involved in planning and executing the initiative.

The study is based on action research (Baskerville and Pries-Heje, 1999; Galliers, 1992; Susman, 1983) with a focus on understanding how action learning can be carried out in a SPI unit and how the organization can benefit from such an initiative to assure SPI success. The research addresses the question 'how can one improve SPI change agents' know-how to improve software organizations'?

Action research is a method that attempts to link theory and practice, which is exactly the aim of this study. Baskerville and Pries-Heje (1999) argue that the fundamental contention of action research is that a complex social process can be studied best by introducing changes into that process and observing the effects of these changes. Action research has three distinctive characteristics (Baskerville and Wood-Harper, 1996). First, the research is actively involved to solve practical problems. Second, the knowledge obtained can be immediately applied in practice and third, the research is a cyclical process linking theory and practice. These three characteristics are all adopted and used in this study. Both the study and the structural of the paper have followed the cyclical action research approach by Susman and Evered (1978) including the five phases Diagnosing (identifying the problem), Action Planning (considering alternative courses fo action for solving the problems), Action Taking (selecting a course of action), Evaluating (studying the consequences of the actions taken) and Specifying Learning (identifying general findings).

Data was collected by the author throughout the initiative as summarized in Table 1. # 1-5 were made available on a website for all participants and # 6-7 were made available on a website for all software engineers. This availability secured that the participants continuously reviewed the collected data. # 8-9 were stored and managed by the author for final analyses. Each time the group met was initially called a 'workshop'.

#	What	Explanation
1	Workshop data	The length of each workshop
2	Workshop preparations	What preparation that took place before each workshop.
3	Workshop content	What papers and ongoing SPI initiatives that were studied, discussed, or reflected upon.
4	Workshop comments	Selected comments during the meeting. Questions that occurred and were discussed in the workshop.
5	Workshop reflections	Selected reflections on the meeting a few days after the workshop. Each participant was asked to send a few reflections through e-mail to the SPI manager about how they perceived the workshop.
6	SPI unit survey June 2003	60 questions with six scale answers were asked through a web questionnaire in the yearly SPI unit survey 2003 to all software engineers in the development unit.
7	SPI unit code review survey December 2003	5 questions with six scale answers were asked through a web questionnaire in an extra SPI unit survey regarding code reviews to all designers within the development unit.
8	Quality course questionnaire	5 questions with six scale answers were asked to all software engineers participating in the quality course. The questions are shown below: 1. The course gave me a good understanding of which quality assurance activities that we use 2. The course helped me understand how to contribute more to product quality 3. The course content was already known to me 4. The course will lead to that I more focused will promote/ perform quality assurance activities 5. The overall value for me to participate at this course was good
9	Final interviews with the SPI change agents in the action learning initiative (Dec 2003)	Seven of the twelve participants were interviewed for approximately 15-20 minutes with the following five questions. 1. What are your overall opinions of the action learning workshops held during 2003? 2. Which are the main things you have learned from the workshops? 3. Have you in any way changed your way of working as a result of the workshops? 4. Do you think any result in the company has improved as a result of the changed way of working? 5. How would you like to see future of the action learning initiative?

Table 1. Data collected throughout the initiative

4. Learning in Action

This chapter presents the initiative following Susmans and Evered's (1978) five phases. It identifies and defines the problem (section 4.1), it describes the plan to solve the problems (section 4.2), it describes the actions taken (section 4.3), it studies and discusses the evaluation of the actions taken (section 4.4), and finally, it identifies general findings (section 4.5).

4.1 Diagnosing

The problems regarding *how* to assure commitment to change and to deal appropriately with reactions to change were perceived as major barriers for successful SPI. Lessons learned in previous SPI initiatives within the company had shown a lack of know-how in these areas (Börjesson, 2003; Börjesson and Mathiassen, 2003; Börjesson and Mathiassen, 2004a; Börjesson and Mathiassen, 2004b). Too many SPI initiatives struggled with the problems around management commitment, to little involvement from senior engineers, and defensive reactions from engineers. These problems became even more obvious in mid 2003 when the result from the yearly conducted SPI unit survey was available (see Table 2). Data showed that the confidence for the software processes had decreased from 2002 to 2003.

Year	**2001**	**2002**	**2003**
Questions	**% positive answers**		
I'm familiar with our software process	78	90	83
I think a work according to our software process	59	77	59
I think the software process supports me in my work	45	73	49
I think the software process is needed	68	85	76
I have good knowledge of the parts in the software process that affect me the most	63	78	62

Table 2. Data from the yearly conducted SPI unit survey

4.2 Action Planning

To react to this problem an action learning approach was set up to learn and understand more about SPI success barriers. In late 2002, the origins for the SPI unit's action learning initiative was developed by the SPI manager (who also is the author of the paper) in close collaboration with colleagues from academia. This collaboration resulted in a number of preferred know-how areas for the SPI change agents from Ericsson to study and learn from (see Appendix, column 4). An idea was that the SPI change agents must constantly be able to change and improve their action strategies to respond to the changing business environment. When the SPI change agents have the capability to learn and reflect in action, the SPI change agents' know-how will improve and as a result of that, the SPI unit will improve and so will the ongoing SPI initiatives.

Six SPI workshops were set up during the spring of 2003 (see Appendix). The workshops were planned on a monthly basis, three hours each time. The content of each workshop was planned and presented to the SPI unit in early January (see Appendix). The subsequent workshops during the autumn of 2003

were planed in June-August, when a first evaluation of the six first workshops was made. The idea was to study, learn, understand, and reflect over basic SPI issues, SPI related theories and, ongoing SPI actions during the spring and then evaluate and use the new knowledge in the ongoing SPI initiatives during the autumn. The appendix describes data from the SPI workshops (also called Methods and Tools forum) based on the characteristics in Table 1 (#1-5).

4.3 Action Taking

Most workshops were held in the Ericsson locations. 12 SPI change agents took part in the workshops and the average participation was 85%. During the spring the SPI change agents were divided into two groups who worked together to prepare and present literature. During the autumn, the SPI change agents worked together dependent on their specific competence and what ongoing SPI initiatives they were inducted in.

The plan was followed closely and in the evaluation of workshop #6 it was decided to plan for the following actions:

- Deploy the 'SPI working principles' that the SPI unit had identified as barriers to successful SPI (Börjesson, 2003; Börjesson and Mathiassen, 2003; Börjesson and Mathiassen, 2004a; Börjesson and Mathiassen, 2004b) to all software engineers. Use established SPI literature to further utilise the findings (Humphrey, 1989;, McFeeley, 1996; Weinberg, 1997). The deployment should be made as a part of a new quality course that the SPI unit should roll out to all software engineers. A specific part, only including SPI working principles, should be defined. All participants should answer a questionnaire to be able to evaluate the result (Table 1, #8).
- Deploy an ongoing SPI initiative regarding code reviews by using an adaptation of the diffusion workshop model (Pries-Heje and Tryde, 2001). Visit Volvo AB and learn from their adaptation work of the diffusion workshop model (Andersson and Nilsson, 2002). A group of four people from the SPI unit took on the responsibility to execute the workshop and then diffuse according to the plans made there. The person responsible for the deployment activities already had the responsibility to assure implementation and use of the new code review strategy in the ongoing SPI initiative.
- Study and learn how people react to change in the trouble report tool SPI initiative where the tool and process should be changed to follow the new Ericsson strategy. A group of five people defined the study. The idea was to learn more of people's reactions to change as a SPI initiative evolved. The theoretical base was the Satir Change model (Weinberg, 1997).
- Continue the SPI action learning initiative. The SPI manager got the responsibility to plan new workshops for the autumn of 2003. It was decided to use the workshops to follow up on ongoing new initiatives

and reflect on what was happening. The idea was also to study new literature, but less than during the spring.

Workshop #7 - 10 focused more on using the acquired know-how in practice, but there was still an intention to study and learn new SPI related theories. The workshops were executed according to plan.

4.4 Evaluating

In early December final interviews were held by the SPI manager with the workshop participants to evaluate the SPI action learning initiative (Table 1, #9). Also, the SPI unit code review survey was made to evaluate the use of the Pries-Heje and Tryde diffusion workshop model (2001) (Table 1, # 7)

In mid November, four SPI change agents had to leave the company due to scarcity of work, so only seven interviews could be conducted out of the twelve participants (the author counted as one of the participants). The total effort put down on the SPI unit's action learning initiative was approximately 600 man hours (12 persons * 0.85 (presence) * 10 workshops * 3 hours + 12 persons * 10 workshops * 2 (man hours for preparations) + 20 (SPI manager preparation time) + 10 * 3 (monthly preparation and follow up by SPI manager). As a comparison the whole product unit's total effort is approximately yearly 850 000 man hours and the SPI unit's total effort is approximately 20 000 man hours.

Table 3 describes the outcome of the important initiatives decided at workshop #6. The final interviews also discovered unexpected improvements as a result of the SPI action learning initiative. Table 4 describes the outcome from questions asked to designers before and after deployment of code reviews was executed.

#	Improvement area	Actions taken	Data after new actions taken
I_1	Deployment of SPI working principles	A 2-hour product quality course was held for 258 software engineers. 1/3 of the course focused only on presenting and discussing good ways of working with SPI (Börjesson, 2003; Börjesson and Mathiassen, 2003; Börjesson and Mathiassen, 2004a; Börjesson and Mathiassen, 2004b).	85% believed the course gave them a good understanding of which quality assurance activities that were used. 66% believed the course helped them understand how to contribute more to product quality. 71% believed the course content was already known to them. 63% believed the course would lead to that they more focused promote/ perform quality assurance activities. 70% believed that the overall value for them to participate at this course was good.
I_2	Deployment of code reviews	An adaptation of the workshop model (Priesheje and Tryde, 2001) was made and a 3-hour diffusion workshop was held with practitioners from all affected units. The outcome of the workshop was then analyzed with help of the surveys made.	See Table 3
I_3	Trouble report tool and process change	A plan for how to measure how people change their attitude as a SPI initiative evolves was made. The corporate Ericsson trouble report tool and process was however delayed, so plan has not yet been executed.	None available due to the delayed corporate tool and process
I_4	Use of measurements and statistics	One of the M&T forum participants believed his capabilities of analysing people's reactions to change helped him stay current and both define and deploy the need of working with measurements and statistics and a regular basis.	A project cockpit including statistics from different areas (status of trouble reports, software builds and test cases) is shown for all main development projects at all project steering meetings. One year ago, this was not in place. Trouble report statistics are used on a weekly basis both to present current situation and to manage resource focus. One year ago the focus on trouble reports was directed to the end of the development projects.

I_5	Use of new change request tool and process	One of the M&T forum participants believed his capabilities of analysing people's reactions to change helped understand how to deploy the new tool and process for change requests in an iterative way.	A small change request pilot tool and process was developed and successfully deployed for one of the development projects. The tool and process is now used by the project and there is a decision to proceed and further develop this work for all the development projects.
I_6	Capability to analyze and reflect in action	Several of the M&T forum participants believed their capability to analyze and reflects in action increased as a result of the M&T forum and the new knowledge they had received. They believe they have improved in understanding reactions to change and stay current in SPI initiatives even when it feels hard to continue.	The SPI unit has despite of lay-offs, re-organizations, tough market situation and resistant practitioners stayed current in all initiated SPI initiatives and performed according to set up plans.
I_7	Employee motivation	All of the M&T forum participants believed that the M&T forums were very valuable. They believed they had got new insights and competences that helped them in their daily practical work. They believed it was a good way of using the competence that the SPI manager received as a result of her industrial Ph.D. studies. It had also given the unit a common way to communicate about difficulties and they had enjoyed participating at the M&T forums. Two of participants have also shown an interest for performing further action research in their daily work.	All SPI change agents believe the M&T forums have been educating, interesting and motivating. They have learned a lot a can use it in their daily work. They want to continue the M&T forum. All final interviews indicate a strong belief in this way of working with action learning, but also that they have enjoyed it a lot.

Table 3. Data from results from actions taken within the action learning intiative

	I participate in code reviews		I think code reviews are efficient the way they are currently performed		I think I gain valuable knowledge about other parts of the system through code reviews	
	Negative	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**
SPI unit survey May 2003 (62 answers)	88%	12%	30%	30%	13%	19%
			40% don't know		68% don't know	
SPI unit survey Dec 2003 (40 answers)	35%	65%	32%	68%	30%	70%

Table 4. Data from code reviews survey

4.5 Specifying Learning

As a result of the action learning initiative and the time given to the SPI change agents to reflect-in-action, both direct and indirect actions were taken. The issue now is to assess what effects this had on the SPI success rate. The direct actions were expected as there had been a decision made at workshop #6 to address a number of areas. The indirect actions taken were more unexpected. They were the result of SPI change agents changing their action strategies for how to conduct SPI work (Argyris and Schön, 1996). In the following section 4.5.1 discusses the direct result, section 4.5.2 discusses the indirect result, and section 4.5.3 discusses the return of investment from the whole initiative. When studying the consequences, the questions of single- and double-loop-learning (Argyris and Schön, 1996) is evaluated. Was there a change as a result of changing the governing variables (double-loop-learning) or a change as a result of new instruments used (single-loop-learning)? This evaluation is, however, only possible if the governing variables for the SPI unit are known. Based on the decision to run an action learning initiative focusing on the role of the SPI change agents it is fare to say that one important governing variable for SPI unit is that 'the SPI change agents' performance and way of working highly affect the outcome of a SPI initiative'.

4.5.1 Direct result

From Table 3, two direct results are shown (I1 - Deployment of SPI working principles and I2 - Deployment of code reviews). The SPI unit used their acquired know-how to decide upon new actions to improve their way of working. For I1 the know-how about importance of deployment, change management, explaining SPI models and follow-up (Grady, 1997; Humphrey, 1989, McFeeley, 1996, Weinberg, 1997) was used and for I2 the know-how

about the diffusion workshop (Pries-Heje and Tryde, 2001; Andersson and Nilsson, 2002) was used. General know-how in knowledge management and organizational learning helped the SPI change agents to better plan for how to diffuse new software practices. Improvement area I3 (Trouble report tool and process change) never ended up in any direct result, but the know-how of the Satir Change Model (Weinberg, 1997) was used to plan the initiative. The data after new actions taken (see Table 3, column 4) indicates that both I1 and I2 gave the organization a positive result. The result of I1 is difficult to objectively measure, as there is no baseline to benchmark towards. The example below shows calculation of a possible return of investment.

Example:

*One software trouble report cost 40 man-hours to fix. If all positive participants (i.e. participants that believed the course would lead to that they would more focused promote/perform quality assurance activities (63%)) would end up in one less trouble report each, that would save 258 participants *63% positive *40 man hours = 6500 man hours. This number should then be compared to the 600 man-hours that the SPI unit's action learning initiative cost. This indicates a return of investment *10.*

The result of I2 is shown in Table 4 and the data indicates a strong positive trend towards use of and benefiting from code reviews after the new actions taken.

4.5.2 Indirect result

Some less expected results are shown in Table 3 (I4 -Use of measurements and statistics, I5 - Use of new change request tool and process and I6 - Capability to analyze and reflect in action). I4, I5 and I6 indicated that using the knowledge to analyse reactions to change (Weinberg, 1997; Grady 1997) increased the use of software metrics in the organization and helped implement a new change request tool and process. I4 also indicates that the knowledge of the need for SPI change agents to stay current through an SPI initiative (Humphrey, 1989) and deploy the results (Börjesson and Mathiassen, 2003) increased the use of software metrics in the organization. I6 indicates that the SPI unit's capability of reflecting-in-action (Schön, 1983) and analysing situations assured that the SPI change agents managed to stay current despite of for instance practitioners resistance and organizational down sizing. The SPI unit managed to improve during organizational changes, which indicates the basic capabilities of an agile unit (Dove, 2001).

Another unexpected result came out of the SPI unit's action learning initiative. I7, Employee motivation, indicates that the motivation of the SPI unit and their work had increased as a result of both understanding more and being able to contribute more in their daily work. The SPI unit also got a common baseline for how to communicate with each other regarding the difficulties they meet.

Boehm (1983) claims that the most outstanding issue for increasing productivity is employee motivation. As a result of the competence development effort, the data after actions taken shows for I7 that the employee satisfaction increased.

4.5.3 Learning and Return of Investment

The SPI unit changed their action strategies and the consequences were positive for the organization, but was it a result of changing governing variables or just changing the used instruments? The SPI unit showed the benefits with making new action strategies, but the actions taken were not of the kind that their governing variables were changed. It was questioned, reflected upon, and strengthened, but not changed. The governing variable 'the SPI change agents' performance and way of working highly affect the outcome of a SPI initiative' was still valid. The SPI unit conducted double-loop learning in the sense that they questioned the governing variables. However, the SPI unit was still performing single-loop learning in the sense that only the action strategies were changed (Argyris and Schön, 1996).

Data from appendix, Table 3 and Table 4 reveals that a fairly small investment (600 man-hours) resulted in many different improvements (I1 - I7 in Table 3). By investing time to increase the know-how of the SPI change agents a number of improvements were identified (see Table 2). Both objective and subjective data indicate increased SPI success rate and return of investment. These positive indicators were the result of the action learning initiative. Through improving the SPI change agents' know-how, the software organization improved. The organization benefited from the action learning initiative and the organization improved by improving their improvers. Double-loop learning was not established in the sense that the governing variables changed, which indicates that single-loop learning (i.e. changing action strategies) itself can be very valuable for an organization. Further research is needed to evaluate whether still performing single-loop learning when governing variables have been questioned can be an indicator of good and solid governing variables.

5. Conclusions

To manage an ever-changing business environment an organization needs to assure that SPI change agents have the right know-how. This study focuses on how changing the know-how for SPI change agents can lead to improved SPI success rate and improved software organizations. Based on experienced SPI problems, an action learning initiative was set up to stimulate both individual- and organizational learning. This research shows how one SPI unit within the telecom company Ericsson AB improved by improving the SPI change agents' action strategies. An investment of 600 man-hours where twelve SPI change agents studied SPI, organizational learning, knowledge management,

diffusion of IT, change management, and agility literature ended up in a number of improved SPI areas. The result was evaluated and discussed based on the single- and double-loop learning theory. Some of the improvements objectively showed an increased SPI success rate, while other improvements more subjectively indicated an increased SPI success rate. The research indicates that when improving the SPI change agents' know-how with help of action learning, the software organization improved. The SPI unit questioned its governing variables, but they did not change them. The SPI unit changed its action strategies through use of new instruments. Single-loop learning was performed and it was shown beneficial for the organization.

Appendix

#	Workshop data	Preparations	Content	Comments	Reflections
W1	2003-01-29	Paper study in groups	Basics of doing research Learn how to read a full academic paper Börjesson and Mathiassen (2003a); Börjesson and Mathiassen (2003b)	How can we learn how to pass the chaos phase faster? How can we best run generic initiatives and still keep focus on deployment? How can we better use process push and practice pull? What do we need to measure to say SPI success?	Good discussions came out of it. We will be able to get the same view on things Very interesting to learn about the "academic world" Good for cooperation in the group Interesting to hear the comments from all people
W2	2003-03-03	Paper study in groups	SPI Humphrey (1989) McFeeley (1996) Paulk et. al. (1995) Mathiassen et. al. (2001) chapter 2 and 16 KM Nonaka and Takeuchi (1995) Hansen et. al. (19YY) Mathiassen (2002)	Within THE SPI UNIT, we try to make tacit knowledge explicit KM theories can be complex The SPI unit has a codified strategy to maintain the process map but a personalized strategy to deploy It is unclear of we would benefit more from having a more obvious KM strategy We need SPI models that visualize the need of deployment How can our SPI work be more proactive	Everyone is involved, all have read their papers; we listen, we comment, we reflect, we laugh It is exciting to widen ones knowledge within addressed areas We could conduct "small investigations" (continue and summarize some of the "Hot topics" from the meeting) on the findings/topics we discuss during the workshop A bit too many papers, since there was little time to discuss how we could change our ways of working, with regard to the theories
W3	2003-03-28 IT Unive rsity Jan Pries-Heje	Paper study in groups	OL Crossan et. al. (1999) March et. al (1991) Brown and Duguid (1991) Diffusion of IT SEI and INTRo Pries-Heje and Tryde (2001) Kautz (2001)	Major problem to communicate from one to may Do we have a common language good enough? How can we better learn from very few happening? Can we learn from non-events? Learning and Innovation does not come naturally. It requires an initiative Why are so many procedures well described but poorly used?	Best workshop so far, we are starting to reflect on what we have read and on how we are working Very interesting to have an external participant Good experience to meet and discuss with an "real" professor It is very much appreciated to have external participants in our discussions, especially in this case when the guest was the author of one of the papers written

#	Workshop data	Preparations	Content	Comments	Reflections
W4	2003-04-23	Recapture in groups	Recapture and summarize what has been learned so far	Use the workshop model/diffusion model (do only minor adaptations) Stay current through an SPI initiative to assure success The SPI unit need to improve in visualising what factors that affect SPI success	Very good to recapture what we have done Maybe we have read too many papers… The workshop model can be beneficial for us
W5	2003-05-21	Paper study in groups	Change Management Weinberg (1997) chapter 1-3 Grady (1997) pp. 92-114	Do not take resistance to change personal Change happen one person at a time It requires passion for change to make change happen How can we act better towards resistance to change?	Change Management is important to have in mind in the daily work Change takes time It is very good that we always start by stating the purpose of this workshop, by summarizing what we have done so far I cannot stress enough the positive importance/ impact this initiative has had for us as a group
W6	2003-06-23 Lars Mathi assen	Recapturing in groups	Recapture and decision how to proceed	Use the name M&T forum instead of workshops Use implementation management instead of workshop Produce lessons, not only discuss problems Focus on the 5.5 project and use the implementation management model to secure code reviews Focus on the Quality course to deploy important factors for successful SPI	No reflections collected
W7	2003-09-09	SPI initiative preparation Paper study by two SPI change agents	Follow up of decided ongoing initiatives	The CQ MIG pilot is delayed due to reason we can not affect Define success goals for each initiative that are measurable Use the SPI unit survey 2003 to benchmark towards Plan for reflections-in-actions, i.e. think what is happening when it is happening	No we use the theory in practice Good input from the group, good to see the other groups ideas We keep learning more and more about change management and implementation of SPI It feels like a big step forward to start using the theories on our ongoing project activities SPI is not about SW, it's about people This gives us a powerful "armour and weaponry" to meet obstacles, understand them and take appropriate actions

#	Workshop data	Preparations	Content	Comments	Reflections
W8	2003-10-06	SPI Initiative preparations. Visiting K. Nilsson at Volvo	Follow up of decided ongoing initiatives Presenting an SPI paper Börjesson (2003) Planning for a Diffusion workshop Andersson and Nilsson (2002)	Can we within THE SPI UNIT improve our way of planning our SPI initiatives in iterations more than today? Different parts of the organization exist in different phases in parallel - a challenge for change agents The planning of action based SPI work comes natural now Volvo IT experiences from the workshop model is useful presentations and handouts	No reflections collected
W9	2003-11-03	SPI Initiative preparations	Follow up of decided ongoing initiatives Agility Dove (2001)	Participants learn how improvement work must be performed Understand agility the concept in theory, but how can we act to become agile? Change in culture and power is needed to implement the agility concept	The relation between agility (Response Ability) and the CMM is interesting. Is the CMM "too old" in that it requires the environment to be more "stable" then it usually is in the year 2003? Good discussions about agility! I believe agility can be a very important area to enable Quality, Efficiency and Predictability
W10	2003-12-15	Paper study by two SPI change agents SPI Initiative preparations	Follow up of decided ongoing initiatives Agility Börjesson and Mathiassen (2004)	Investigation of code review performance after the diffusion workshop: Good Result Presentation of Q course result: Return on investment on 17 100 000 SEK The agility paper is interesting, but what other factors do also affect the result?	We want to keep working with the M&T forum also next year We have learned extremely much during the year It is hard to find the time to prepare for the M&T forum, but still it is very valuable

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Supplementing Ron Weber's View on a Theory Building

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Abstract: *The information systems science needs its own theories. To this end, the method to develop a new theory which Ron Weber, Editor-in-Chief of MIS Quarterly, recently presented is very welcome. The method with the four steps is not, however, universal, i.e. it cannot be applied to every case. We shall show three different exceptions. First, based on the analysis of the lawful states of the novel system we shall demonstrate that the innovative system building task must be excluded from the application domain of that method. Secondly, by using different categories of dynamic systems we show that the method can be applied to the nilpotent systems with the rest point, but the method cannot be applied to the self-steering systems. The latter is pity, because the self-steering system is the most natural model of the total intellectual process of human being, i.e. the consciously controlled human tasks cannot be theorized by using the method presented by Ron Weber. Thirdly, because of social construction of reality and the fact that constructs are grounded in common understanding rather than physical reality so the possibilities for differing interpretations are great. Further, they may become out dated as common understanding can change.*

Keywords: *Theory, systems development, human being, dynamic systems, method*

1. Introduction

"Nothing is as practical as a good theory" is a phrase we sometimes hear. Interaction between theory and practice is two-directional. Theoretical constructs guide our acts and our practice shapes our theoretical view on the world. We see our world through our theoretical lenses. Giddens (1984, p. 326) uses an expression a *sensitizing device,* when he means the role of a theory, model or theoretical framework in observing of a part of the world. Orlikowski (2000) developed a new concept a *practice lens*, which posits

human as constituting structures in their recurrent use of technology. The practice lens she is proposing focuses on emergent technology structures enacted in practice rather than embodied structures fixed in technologies. This practice lens further recognizes that in both research and practice researchers often conflate two aspects of technology: the technology as artifact (the bundle of material and symbol properties packaged in some socially recognizable form, e.g. hardware, software, techniques); and the use of technology, or what people actually do with the technological artifact in their recurrent, situated practices.

Ron Weber was an invited speaker in the 26th IRIS in Haikko, Finland. He presented the ideas which he was included into his own column MIS Quarterly (2003, pp. iii – xii). In these editorial comments, Ron Weber addressed the topic of theory building. His motivation is fourfold. First, he believes that, as members of a discipline, we still need to improve our theory-building skills. In his view, we still rely too much on theories borrowed and adapted from other disciplines – perhaps a manifestation of our need to build theories in domains where no prior theory exists. Second, much more has been written about theory testing than theory building. He hopes these editorial comments might help by providing some useful pointers on how to build high-quality theory. Third, he wants to reiterate Bob Zmud's call for more theory-only submissions to the MIS Quarterly (June 1998). Via these editorial comments, he hopes to illustrate the ways in which such submissions might be crafted and the types of contributions to knowledge that theory-only submissions might seek to make. Finally, he wants to canvass briefly some controversial issues relating to theory building – for example, whether theory building is even a meaningful activity to undertake within our discipline and, if so, what forms it should take. His hope is that his comments will motivate more discussion and debate on these issues – issues that perhaps some of us would prefer to shun because of the challenges they present to our long-held beliefs about theory.

In their survey article Lee et al. (2003) support the Ron Weber's arguments by claiming that the technology acceptance model (TAM) is almost the only own theory which information systems science has. We really need new own theories for phenomena under our studies, especially in our core area independent on is it narrower (Benbasat & Zmud, 2003) or broader (Alter, 2003).

I shall in this paper participate in discussion and debate on theory building as Ron Weber wishes. To develop a necessary basis for discussion I have in Section 2 repeated his mean message, i.e. his four major steps associated with theory-building which I call the RW method. My threefold criticism concerns applicability of the RW method. I shall show that the RW method cannot be applied to the systems development process (Section 3), to a certain kind of dynamic system (Section 4) and to social sciences (Section 5).

2. Ron Weber's view on theory building

In this section we shall present Ron Weber's (2003) own method for theory building. Because the method plays an important role, we described it in detail. A theory is an *account* that is intended to explain or predict some *phenomena* that we perceive in the world. The terms *account* and *phenomena*, however, have particular meanings. Weber will explain the latter first and then the former.

To understand the meaning of the term phenomena, Weber first needs to cover some basic ontology. For him, the two fundamental (atomic) constructs the researcher needs to be able to describe anything shee perceive in the world are *things* and *properties of things*. The values of the properties of some thing at a point of space-time are its *state*. Changes of state (changes that occur in the values of properties) are *events* that occur to a thing. Perhaps a counterintuitive idea, however, is that the states of and events that occur to a thing are also properties of the *thing*. States and events do not exist in the ether. They "belong to" some thing. Thus, they are properties of the thing.

Phenomena are the states of things or events that occur to things. When the researcher builds a theory, therefore, she is seeking to account for the state(s) of some thing (or things) or an event(s) that occurs to some thing (or things). … The theory she seeks to build in essence is an attempt to articulate a *law* (or less formally an association or statement) that relates the value of two components of the user's state. … She might have articulated the theory at the outset of her research on the basis of prior research and her own knowledge and experience. Alternatively, she might have articulated it only in light of insights she has obtained after long period of intensive data gathering in the field. Whatever the scenario, the phenomenon she is seeking to explain or predict is the relationship among values of various components of the state of a particular thing. … Weber finally defines that the *account* of the phenomena is the explanation of the laws that are hypothesized to relate them – laws that specify the relationships between the values of different properties of a single thing, or laws that specify the relationships between the values of properties of different things. Often an account is couched using the terms *construct* and *association* among constructs. A construct is simply a property of a thing (either a simple thing or a composite thing). An association is simply a law (formal statement of some kind) that is hypothesized to govern the values of different properties (properties of the same thing or different things) or changes to the value of properties of a thing.

Weber (2003) writes that "building good theories is in part an art – an activity that requires creative insights on the part of the theory builder. Broadly, however, there are procedures we can follow. Below Weber have provided a brief description of four major steps associated with theory-building endeavors. For each step, he has also indicated how as scholars we might make theoretical contributions to our discipline. Also while his comments below imply that scholars follow the steps sequentially, clearly the process of building theory is iterative.

Step 1: Articulate the constructs of a theory

The most fundamental components of a theory are its constructs. Recall, the constructs represent properties of things. A theory seeks to explain or predict the values of or changes in the values of these properties. Often some subset of these properties is likely to have a special status in her theory building. They represent the so-called dependent variable (or variables) that the researcher is seeking to explain or predict. They are the focal construct (or constructs) in her theory. The other properties are of interest to the researcher because she believes they are associated in some way with changes in the value of her dependent variable(s). They are the ancillary constructs in her theory. In some cases, however, there is no focal construct *per se*.

Her choice of the constructs to include in a theory is a critical decision. The focal constructs she "sees" in the world and the ways she conceptualizes them are likely to have an important impact on the contribution to knowledge she makes via her theory. Furthermore, in her choice of ancillary constructs, she has to make important trade-offs between richness and parsimony in her theory.

Step 2: Articulate the laws of interaction (relationships) among the constructs of a theory

Once she has chosen her constructs, she then needs to explain how they are related to one another – in other words, how their values change in concert according to some sort of *law*.

Her laws of interaction can be specified with varying levels of precision.

Step 3: Articulate the lawful state space of a theory

The lawful state space is the set of combinations of construct values for which the theory is expected to hold. It is one element of the *boundary conditions* of a theory.

She begins to specify the lawful state space of her theory when she selects the constructs to include in her theory. The choice of constructs dictates the *things* in the world to which her theory applies. … Given her choice of constructs, her theory might apply only for certain values of each of her constructs. … In principle, she also needs to consider all combinations of values of her constructs.

Step 4: Articulate the lawful event space of a theory

The lawful event space is a set of changes of state of the constructs for which the theory is expected to hold. As with the lawful state space, the lawful event space is an important element of the boundary conditions of a theory.

In some cases, an event is unlawful because either the prior state or the subsequent state is unlawful. In some circumstances, however, both the prior state and the subsequent state are lawful but the transition between them is unlawful.

3. The systems development process

In this section we shall analyze the systems development, its lawful states and transitions between states. The systems development can be described as follows: According to March and Smith (1995) design science products are of four types of artifacts: constructs, models, methods, and instantiations. We use their definitions. *Constructs* or concepts form the vocabulary of a domain. A *model* is a set of propositions or statements expressing relationships among constructs. A *method* is a set of steps (an algorithm or guideline) used to perform a task. An *instantiation* is the realization of an artifact in its environment.

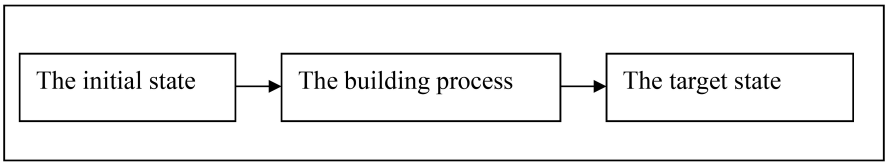


Figure 1. The building process

We would like to enlarge the artifact concept to the innovation concept. Instantiations operationalize constructs, models and methods. The motivation behind the building a new innovation is either lacking of that innovation or low quality of the outcomes achieved by old innovation. It is almost always possible to identify the starting point of an effort to construct something new and also the contemporary view on the desired state, e.g. the functioning artifact. The purpose of the construction process is to achieve a movement from the initial state to the target state (Figure 1).

In Figure 1 there normally are two states and one process, i.e. a transition from the initial state to the target state. According to the RW method, our state space consists of two (initial and target) states and our event space of one transition.

In few cases the initial state can be lacking, i.e. we do not have any earlier innovation, in other words the building process of the new innovation will be started from scratch. A developer/researcher may have her own ideas about the desired state. But it cannot be based on the business need as Hevner et al. (2004) require, because the innovation to be built is totally new and anybody does not know whether the new innovation will be a success in business sense before it will enter to the market. In this situation we have difficulties to apply the RW method.

In the normal case, some of the interested parties have perhaps considered the initial state to be problematic. The performance criteria of the old version of artifact or innovation may be below the stated goals. Some party can also have an idea or a concept to apply or to use some resources (technological, human, data/ information/ knowledge, financial resources) in a new way in order to solve the problem. This concept resembles a business concept or business idea. In practice it can be a new theoretical or practical, e.g. technical invention.

March and Smith (1995) connect two models to two states, the first one to the initial state and the second one to the target state, in such a way that the models represent situations as problem and solution statements. It means how things are at the beginning and how they ought to be at the target state (a normative model). The (positive) model of the initial state may need to capture the structure of reality in order to be a useful representation. The positive model or theory of the initial state of the old information system describes both the structure and behavior of the system. The normative model of theory of the target state describes which kinds should be both the structure and behavior of the new system. To our mind, at least the positive model (but maybe the normative one, too) can be built by following the RW method. But we see some problems with the development process for the new system. - As we earlier said the reason for building the new innovation is "either lacking of that innovation or low quality of the outcomes achieved by old innovation", but Ron Weber does not speak anything about, for example, "quality of outcomes". Before discussing this important theme, we would like to slightly elaborate our simple Figure 1.

To emphasize the utility aspect motivating construction the (problematic) initial state is evaluated by using a certain utility metrics (or many), and the target state is estimated to be better, more valuable, more desired with the same metrics. The model of the initial and/or target state can (but need not) contain one or more new constructs.

To think the building task, the target state can be known or unknown. If it is known, the task of researchers as builders is to try to implement the desired change from the initial state to the target one. If the target state is unknown, we have at least two alternatives.

We can firstly specify the target state and then try to implement measures to achieve that state or we can in parallel realize both target-seeking and implementation. Instead of implementing the totally new version of artifact by ourselves, we can also purchase a ready-made artifact, if such one exists and is for sale at a competitive price. The good hopes of builders will not always materialize, but the final state may differ from the target state (Figure 2).

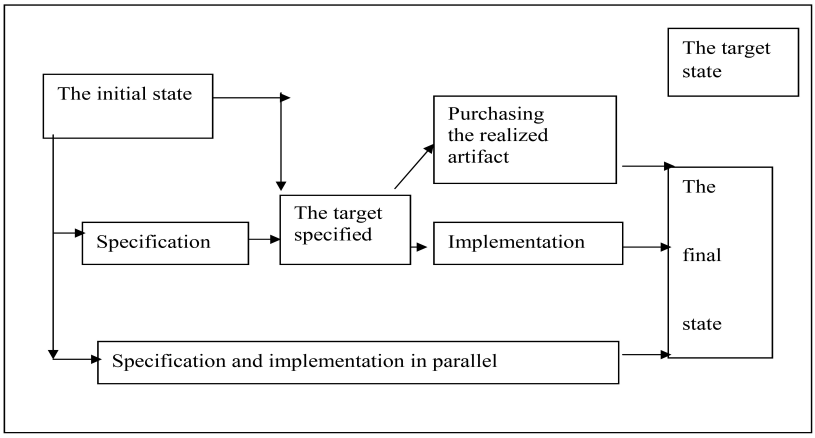


Figure 2. Different alternatives concerning the building process and its outcomes

Our aim is to develop some criteria and measures to estimate the building methods, too. We therefore return to the views on methods taken by March and Smith who assume a well-structured building task and therefore emphasize the implementation process only. We cannot totally agree with them, because at the beginning of the specification and parallel processes there does not necessarily be any model representing the solution space (i.e. the building task is ill-defined). The task of the specification process is to find that model. The other path from the initial state to the final state goes via the parallel process, and its idea is to define the solution space model in the course of the process from the initial state to the final one.

Hence, our Figure 2 represents a wider and realistic view on the processes where the building methods are needed. We can here conclude that the views of March and Smith concerning a method are rather restricted and only applicable to the implementation process where the models of the initial state and the target one exist by definition.

Our 'theory' of the systems development in Figure 2 seems to have four states (initial, specified, target and final states) in the lawful state space of the theory and four transitions (specification, implementation, purchasing and parallel processes) in the lawful event space of the theory. At beginning of the building process all the stakeholders wish that the final state were the target state, but it does not always take place. Is the target state lawful, if the final state after the development effort does not coincide with the target one, i.e. there is no transition from other states to the target one? We claim that our view in Figure 2 corresponds to reality, i.e. in practice it often takes place that the systems development project does not always achieve the target state. The final information system can be better or worse than planned. Our reasoning above shows that we cannot follow the RW method.

In our description above we use 'a certain utility metrics' in evaluating the problematic initial state and the desired target and final states. But the RW

method does not have any such metrics. The reason for that can be the difference between the design science and the natural science. March and Smith (1995) and recently Hevner et al. (2004) carefully describe that difference. Hence, we propose that some additional boundary conditions (cf. Mathiassen, 1981; Mathiassen & Munk-Madsen, 1986) are needed in the RW method: The four steps method is not valid for the research problems in the design science.

4. On dynamic systems

In this section we shall use mathematical notions for very strict description. A reader who does not like those notions can read the verbal text and examples only, and she can get an overview of our message. Aulin (1989) differentiates three primary types of causality: causal relation, causal law and causal recursion, from weakest to strongest one. Causal recursion is the type of causality required at the fundamental level of physical theory, and thus at that of natural science generally. It implies a complete state-description of the dynamical system concerned, given by a total state x, as a function of which any property x of the system at any moment t can be expressed: z(t)=z(x(t)). *Causal recursion* is defined for the total state x if there is a transitive recursion of x(t) to any past state x( ), i.e. if

$x(t) = \varphi^{t\tau}(x(\tau)),\ \varphi^{tt'} \cdot \varphi^{t'\tau} = \varphi^{t\tau}$ for $t > t' > \tau$

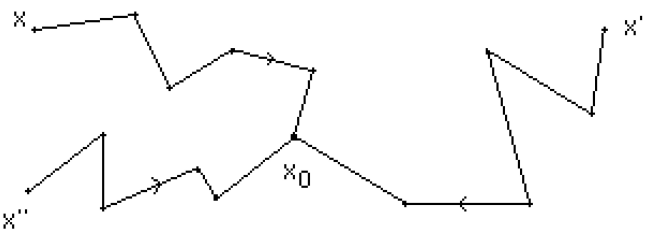
Thus a system having causal recursion is what Ashby (1972) called "state-determined system".

Causal recursion is *nilpotent,* if there is such a positive integer s and state x_0 that

$\varphi^{s}(x) = x_0 \ \forall\ x \in X\ (E)$

$\varphi(x_0) = x_0$,

where E is an Euclidean space and X is a set of states of the system.



The initial state x_0 is called the rest state and the nilpotent dynamical system has the property that it comes back to its initial state after the finite number (s) of units of time. We can say that an external disturbance (or stimulus) occurring at the moment t=0 throws the system out of its rest state x_0 to a perturbed state x, after which the nilpotent causal recursion conducts the total

state xt=u along the half-trajectory uT^+ until, at the moment t=s, the system is back in the rest state x_0. During its return journey the system gives response to the stimulus. If the same stimulus is offered again, the system gives the same finite total response. Thus it is a memoryless system that does not learn from experience.

If the nilpotent system contains feedback, it is called a cybernetic nilpotent system. If a computer is programmed to solve a finite problem, i.e. a problem that can be solved in a finite number of steps of computation in the machine, it is the cybernetic nilpotent system. (But computers can also be programmed to simulate systems that have a full causal recursion.)

A dynamical system with a full causal recursion does not have any rest state to be reached in a finite number of steps (in a finite time). The causal systems can be classified to two categories: nilpotent systems and systems with a full causal recursion.

causal systems
|
|--- nilpotent systems
|
|--- systems with a full causal recursion

The mathematical definition of "goal" is based on an infinite process, and thus on a full causal recursion (Aulin 1989). To define exactly the difference between a goal and a task, Aulin assumes that an external disturbance throws the system at the moment t=0 from an unperturbed state x to a perturbed state p. Corresponding to the alternative cases, related to the behavior of the Euclidean distance (pt, xR^+) of the point pt from the half-trajectory xR^+ and to the boundedness or unboundedness of xR^+ we have the following four types of systems with full causal recursion:

1. If, for a small enough δ-neighbourhood S(x,δ) of x, the Euclidean distance $\rho(pt,xR^+)$ -> 0 with t -> +∞ for all pϵ(x,δ), and if the positive half-trajectory xR^+ is unbounded, the system is called *self-steering in state* x.

2. If the convergence of $\rho(pt,xR^+)$ is as above, but the half-trajectory xR^+ is bounded, the system is called *self-regulating in state* x.

3. If, for a small enough δ-neighbourhood S(x,δ) of x, the Euclidean distance $\rho(pt,xR^+)$ remains finite for all pϵ(x,δ), but does not for all pϵ(x,δ) converge to zero with t -> +∞ , the system is called *steerable from outside in state* x.

4. If in any δ-neighbourhood S(x,δ) of x there is a point p for which $\rho(pt,xR^+)$ -> ∞ with t -> +∞, the system is called *disintegrating in state* x.

Here S(x,δ) is the open sphere with centre x and radius δ. The four definitions obviously exclude one another, and together exhaust the class of all the dynamical systems having a full (i.e. non-nilpotent) causal recursion.

causal systems
|
|--- nilpotent systems
|
|--- systems with a full causal recursion
|
|--- self-steering systems
|
|--- self-regulating systems
|
|--- systems steerable from outside
|
|--- disintegrating systems

We can ask: Can we find any real system in every category, for example, which real system belongs to the category of *self-steering systems*? If the uniqueness of the states of mind, along with the goal-oriented nature of thought processes, is typical of human consciousness, the only thinkable causal representation of what takes place in human mind in an alert state is the self-steering process. It is, however, necessary to limit the interpretation so that what is self-steering in human mind is the *total* intellectual process. All the partial processes needn't be self-steering.

Real-world examples of *self-regulating systems* are: a ball in a cup that has the form of a half-sphere, a room equipped with a good thermostat (self-regulating equilibrium systems); some living organisms like a heart (periodically pulsating self-regulating systems); etc.

A flying ball (the resistance of the air is negligible), a frictionless oscillator and a robot are examples of *systems steerable from outside*.

A radioactive atom and a dead organism are *disintegrating systems*.

I repeat that for the *nilpotent systems* "an external disturbance throws the system at the moment t=0 from an unperturbed state x to a perturbed state p." By using Ron Weber's terminology this means: A certain event moves the system from state x to state p. If state x is the rest state the system always returns from state p to state x via the same path and in the finite number of transitions. It seems to me that the RW method is suitable for the nilpotent systems.

But do the other categories of dynamic systems obey the rules of the RW method? We above cited Aulin, that the self-steering system is the best model of the total intellectual process of human mind. The self-steering system has a special feature: The same state never returns, i.e. it always moves to the new state. The number of new states of the self-steering system is continuously increasing. Ron Weber in his four steps method implicitly assumed that the number of states in a theory is finite, because the lawful states and lawful transitions are enumerated beforehand. But the self-steering system does not obey those requirements. Hence, the Ron Weber's theory-building method

does not contain self-steering systems. If the property of human being, that she never returns to the same state, is essential in some human task, the theory containing such kind of tasks cannot be built by using the RW method. Hence we can conclude that the RW method is not applicable to all kinds of dynamic systems.

5. On social sciences

Hevner et al. (2004, p. 76) write: "The behavioral-science paradigm has its roots in natural science research methods". The assertion is not necessarily exact, because Lee and Baskerville (2003) show that "… interpretivism acknowledges the existence of a phenomenon that is not present in the subject matter studied by the natural sciences. People, who are integral to the subject matter that a social scientist observes, develop and use their own subjective understandings of themselves, their setting, and their history. Therefore, already present in the subject matter of the social sciences are the meanings that people create and that they attach to the world around them. In this sense, subjective meaning is objective reality: The meanings that human subjects create, communicate, and hold are part and parcel of the world that a social scientist receives as the subject matter under investigation. The presence of humanly created, and therefore sometimes contradictory, meanings and socially constructed realities in the subject matter of the social sciences has no counterpart in the subject matter of the natural sciences: 'The world of nature, as explored by the natural scientist, does not 'mean' anything to molecules, atoms, and electrons' (Schutz 1962-66, p. 59)."

For theory-creation the phenomena existing in the social world must have shared constructs with shared meanings. Those constructs are grounded in common understanding rather than physical reality so the possibilities for differing interpretations are great. Further, they may become out dated as common understanding can change. Hence, we can conclude that the lawful state space of a theory or the lawful event space of a theory or both will change as common understanding will change. To this end the RW methods is not applicable with social sciences.

Our conclusion will get support from Orlikowski (2000) who differentiates technologies and technologies-in-practice. "The latter can be and are changed as actors experience changes in awareness, knowledge, power, motivations, time, circumstances, and the technology. They are changed through the same process that all social structures are changed – through human action. People may change their technologies-in-practice by deliberately modifying the properties of their technology and thus how they interact with it."

6. Discussion

In Section 3 we achieved the result that the RW method is not valid for the research problems in the design science problems. It is mainly based on the differences between design and behavioral sciences, which Hevner et al. (2004) describe nicely. The utility aspect emphasized in the design science problems may be the central reason.

In Section 4 we demonstrated that concerning dynamic systems the applicability of the RW method varies. The RW method seems to be suitable for the nilpotent systems, but it is not applicable to self-steering systems, which in the best way model a human being. It is indicative that Hevner et al. (2004) in their article on design science in Information Systems research exclude people from IT artifacts. They write "we do not include people or elements of organizations in our definition [of the IT artifact] nor do we explicitly include the process by which such artifacts evolve over time". They do not give any evidence nor reason for their exclusion, but they may, at least implicitly, guess or know that people as a research object much differ from data and material.

In Section 5 we found that the shared understandings which people have may change in the course of time. To this end the lawful state space of a theory or the lawful event space of a theory or both must be changed, accordingly.

In sum, our main result is that the RW method is not universal but only applicable to some research problems in information systems research, to such phenomena where the objects under study behave regularly. If a researcher wants to apply the RW method in her theory building and also wants to include people into her theory of a certain phenomenon, she must assume that people behave as machines. Otherwise she must select some other approach than the RW method in her theory building.

Aulin (1989) applied mathematics to study different dynamic systems. He writes that if we cannot directly measure something, we could try to use indirect ways. When we cannot directly study free will and human self-steering, we can use, as he demonstrates, for example, mathematics to build the model is close enough to human being with free will. To slightly generalize the basic notions or constructs Ron Weber (2003) used do not have a sufficient expressing power, but Aulin's constructs seem to give some new results. We conclude that the constructs used in the theory building can either inhibit or make the theory building possible.

We have some problems to be studied in the future in our mind. First, the parallel IS system building, i.e. to realize both the specification and implementation process together by using, for example, prototyping, much resembles the trajectory of human being, the tentative candidate of the new system always moves into the new state. This process does not seem to follow the RW method, but it should be demonstrated. Secondly, the other categories than nilpotent and self-steering ones of dynamic systems, although not so important for IS knowledge building, must also be studied.

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MIS and the Problem of Decoupling in E-government Reforms

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***Abstract**: Through a case analysis of the development and use of a MIS in a local health care organization in Norway this paper investigates the concept of decoupling in neo-institutional theory. We view the process of development and use of the MIS as an active element in the reform processes going on in the sector. We argue that the theoretical dichotomy between the symbolic and the substantial inherent in the concept of decoupling conceals the relational connections between them. We risk excluding ourselves from important research questions when we theoretically operate with such a dichotomy. We further argue that decoupling can be considered a special case of coupling i.e. that decoupling is something that is produced and operates as a way of managing problems and constructing solutions and thus influencing action. Using actor-network theory we analyze processes of coupling - decoupling occurring during the process of developing the MIS. We conclude the paper discussing how the MIS, from being an ongoing failure, incrementally turned into an important element in the economic management of the organization thus contributing to a tight coupling between NPM reforms and MIS development.*

***Keywords**: MIS, Healthcare, Neo-institutional theory, Actor-network theory, decoupling, coupling, power.*

1. Introduction

This paper investigates the decoupling hypothesis, as it is formulated in neo-institutional theory (Meyer and Rowan 1977). Our focus is on public reforms and the role of MIS (management information system). E-government refers to IT-enabled change in governmental institutions at all levels from national to regional to local (Kawalek, Wastell, and Newman 2003). Our point of departure is that these IT-based change efforts are, to a great extent, elements within broader streams of public reforms, namely new public management (NPM). Although NPM is heterogeneous as a reform movement it is characterized by a rational perspective on organized action i.e. a focus on rational choice and design and the formal organizational structure as the mean to achieve stated goals (Scott 1992). Further, these goals are to a great extent centered on efficiency and effectiveness, considering the citizen as a consumer in a market. Critics of public reforms expressed from within the field of neo-institutional theory attack the strong assumption of rational choice and the unrealistic assumptions of social control inherent in public reform programs (Brunsson and Olsen 1993). According to these authors the decoupling of the formal structure and practical action explains the problem in making public reforms work as intended. It is argued that they may have an effect on the symbolic level but do not have any substantial effect on organizational practice.

Decoupling designates a distinction between the formal structure of an organization and its actual day-to-day activities. The formal structure is considered as myths and ceremonies and does not necessarily correspond to technical efficiency. Similarly, two sets of organizational processes evolve, one concerned with the production of goods and services, and one which is displayed to the rest of the world. Relative to the orthodoxy of organizational theory focusing one-sidedly on substantial effects, neo-institutional theory with its focus on the symbolic and constructive nature of organized action has greatly extended our understanding. We agree that public reforms have effects on the symbolic level, but we are critical towards the proposition that they do not have any impact on practical organizational action. On the contrary, we state that the dichotomy between the symbolic and the substantial has to be translated into a relation between these two dimensions. We also agree that there is no perfect link between formal prescriptions and actual practice. In that sense the concept of decoupling is productive because it opens up a more thorough understanding of organizational change and public reforms. But we need to go further and investigate how structural reforms become enmeshed with organizational practice and with what effects. Thus we propose to consider decoupling as being a special case of coupling, i.e. that decoupling is something that is (re-) produced, operating as a way of managing problems and constructing solutions, and thus influencing action. This implies that we are not only interested in decoupling as such, but also how things are coupled, particularly through the use of IT in public reforms.

Researchers within neo-institutional theory, who have studied public reforms, have given us insight into the complexities of public reform efforts taking

a critical stand (Brunsson and Olsen 1993). But this research focuses very little on IT. Orlikowski and Barley (2001) argue that because of important epistemological differences between the fields of information technology and organization studies much can be gain from greater interaction between them. They also argue that information technology research can benefit from institutional analysis while organizational studies can benefit by following the lead of information technology research in taking the material properties of technology into account.

In this paper we analyze decoupling in practice using a historical case concerning the development and use of a MIS (Management information system) in a local health-care organization in Norway. We illustrate how the development of the MIS is related to the reform process going on in the municipality. The point of departure is neo-institutional theory, but to elaborate our argument we use insight from the IT academic field. This paper does this by using actor-network theory (ANT), which we believe is suitable for understanding how technological artifacts are important elements in processes of decoupling-coupling in public reforms.

We begin the remainder of this paper by outlining our theoretical framework, arguing that decoupling as it is framed within neo-institutional theory can be investigated in a more meticulous way by using actor-network theory. Next, the research design is presented, followed by background on reforms and discourses on the restructuring of local and national public health care in Norway. The next two sections comprise the empirical core of our paper, a historical reconstruction (1987-2003) of the MIS development in the municipality of Trondheim. The final two sections consist of our discussion, interpretation of the implications of the process, and concluding remarks.

2. Theoretical framework

Neo-institutional theory has its focus on how values, norms and moods of rationality influence the way organized action unfolds (Scott 1992). One of its distinctive features is that it calls attention to cultural and normative frameworks in the environments of organizations and to formal governance structure within them. Organizational structures are argued to have importance apart from, and regardless of, their impact on participant behaviour. The structures are viewed as signalling purposefulness and rationality internally, but especially to external audiences, as demonstrating the organization's connection to and congruence with wider belief and rule systems (Scott 1994).

Within a neo-institutional perspective formal organizational means such as MIS are considered rationalized myths. Rationalized myths are impersonal (collectively defined), taken for granted notions, about what kinds of means are "rational" relative to given (institutionalized) ends. They are embedded in institutional environments and tend to persist over time because they are

deeply rooted in professions, programs and technology (Meyer and Rowan 1991; 41,). In organizational fields that undergo changes and reform efforts there will be conflicting and competitive rationalities and complex and conflicting environments.

Heterogeneous functions, tasks, professions, client groups, and organizational cultures are key features of public healthcare services at the local governmental level in Norway. The heterogeneity is reflected in different organizational principles that are in simultaneous action. This combination makes it possible to strike a fragile balance between differing interests and values, but at the same time it creates dilemmas and contradictions between democratic, administrative and professional rationalities. Institutional values, such as the right to participate in critical decision-making (a democratic logic), must compete with the necessity to manage and control the organization (an administrative logic) and the professionals' claim for autonomy within their domain (a professional logic). The key to holding this together is the clients. On a general level, they represent a shared legitimizing base for all actors in the field, but this does not mean that there is agreement about how to deliver care to the client. When the actors express their opinion more concretely, they reflect the values and interests that prevail in their own domain. Accordingly, human judgment is an important element. This judgment gives rise to difficult discussions and negotiation about how to prioritize and what criteria to use. It is a complex mixture between professional, administrative and political judgments.

According to Barley and Tolbert (1997) neo-institutional theory, although concerned about the dynamic relation between action and structure, has to a large extent ignored the processes by which structures emerge from, or influence action. We agree with these considerations and argue that by focusing on how structures emerge within an organizational practice we can produce insight about how decoupling may or may not occur as a contingent process. In that respect we intend to combine actor-network theory with neo-institutional theory.

2.1 Decoupling

According to Brunsson and Olsen (1993) the hypothesis of decoupling goes as follows: when environmental norms and perceptions do not coincide with what is required for effective action and rational production we can expect organizations to develop two sets of structures, processes and ideologies – one for each sets of demands. Moreover, for the organization it is important that these parallel sets do not disturb one another, and they therefore tend to be decoupled, separated and isolated (Brunsson and Olsen 1993). They write:

"In practice the result is two organizational structures. The formal organization the more visible one and which is relatively easily adapted to the institutionalized norm of society. At the same time the organization can use a

completely different structure for coordinating its activities. Similarly two sets of organizational processes also evolve, one concerned with the production of goods and services, and one which is displayed to the rest of the world but has little or no effect on production." And they continue: "similarly it is possible to affect people's picture of an organization by talk, changing a name or projecting an image through symbols without necessarily changing any structures or processes. Public reform then has an impact on the level of meaning i.e. signaling that the organization is open to change and renewal. Such an approach helps to explain why so many reforms are attempted, even though they have little effect on structures and processes, let alone on results." (Brunsson and Olsen 1993)

As stated above, we argue that the way decoupling is conceptualized is based on a dichotomy between the symbolic and the substantial. We are critical of this and we turn to Actor-network theory to be able to analyze processes of coupling/decoupling.

2.2. Actor network theory

According to ANT, humans and non-humans are linked together into actor-networks (Hanseth and Monteiro). Further, ANT assumes that (a section of) society is inhibited by actors pursuing interests. An actor's interest can be translated into technical or social arrangements, for instance an IS or organisational routines. A basic question it sets out to explain is how a diverse group of actors reaches agreement at all, that is, how a social order establishes a certain degree of stability or exhibits structural properties. According to ANT, stability is the end-result of the social process of aligning an initially diverse collection of interests to "one"; acceptance, "truth" or stability is the result of reaching a certain degree of alignment of interests (Callon 1991). Thus within ANT decoupling can be considered a special case of coupling e.g. a reform project may not succeed in that there is a lack of alignment of interest and the project may turn into a highly symbolic one.

The strength of ANT is that it provides a language for describing how a translation takes place on a quite specific and concrete level (Monteiro 2000). In that respect the notion of inscription is important (Akrich 1992; Akrich and Latour 1992). An inscription is the result of the translation of one's interest into material form (Callon 1991). This creates a link or a coupling between the material and symbolic. In general, any component of the heterogeneous network of skills, practices, artefacts, institutional arrangements, texts and contracts establishing a social order may be the material for inscriptions.

ANT systematically blurs the distinction between the technical and the non-technical. This implies that also symbols, language, organizational recipes act as elements in the process of construction. It also implies that technology receives the same status as human actors. The distinction between human and non-human actors is systematically removed. The solution reached is

constituted by an aligned actor-network. To achieve this, it is vital, as actors' interests from the outset are non-aligned, that one is successful in translating, that is, re-presenting or appropriating the interests of others to one's own (Latour 1987). From this it follows that ANT focuses on how elements are coupled through the alignment of interests and if there is decoupling it is an effect of the way the actor-network is constructed.

To sum up: using actor network theory coupling or decoupling is viewed as an effect of the way the actor-network is constructed. Alignment of interests represents a kind of coupling while the failure to reach alignment might be considered decoupling. More importantly, to analyze how (de-)coupling eventually occurs we must analyze/describe how the actor-network is constructed. This also opens up the road to analyze coupling/decoupling in relation to how it effects power relations. Given that contradictory logic, values and interests are at work in the way the MIS is inscribed into organizational practice also indicates how it is influenced or influences these logics, values and interests.

3. Research methodology and collection of data

Four sets of qualitative data form the empirical basis of this paper. These include participative observations, interviews, informal discussions and electronic and paper based documents. The participative observations are due to the fact that the author worked as an organizational consultant and planner in the organization from 1989 to 1994. Eighteen interviews were carried out from 1997-2003 with key actors. In addition, three group interviews/ discussions have been conducted. The objective of these interviews has been to reconstruct the story by tracing important events that have had an impact on the development of the MIS. In addition, there have been informal conversations during the process of reconstructing the story. Finally, various documents have been reviewed and included in the background research. The documents include project schemes, project plans, internal memos, and project evaluations, political plans for the health care system, and documents on national policy reforms.

4. The field study

The location of this study is the city of Trondheim with 150,000 inhabitants. The local government as a whole has about 10,000 employees, of which 3,200 are employed within the Health Care sector. The main client groups are the elderly, the developmentally disabled, and people with mental illnesses. During the period from 1987 to 2003, health policies were relentlessly

reformed. The reforms ranged from sector-specific improvement within the municipality and local administrative reforms on the local governmental level to national sector-specific reforms. The main strategic issue driving these changes in the health-care field was the increase in the percentage of the elderly within the population. Coping with this increased demand required developing new ways of service production to find a balance between scarce resources and the maintenance of good quality of service. In that respect, an important controversy was the allocation of resources between home-based services and services provided in nursing home settings. The trend has been to prioritize home-based services at the expense of institutions. The legitimizing basis for this is that such a strategy contributes to better quality of service for each client and is the most effective use of resources on the organizational level. But the challenge, seen from the point of view of management, is how to find the right balance between these two services. This strategic issue is a mix of politics, organizational and technological issues. The MIS should be an instrument that provides the administration with a knowledge base that documents the positive effects of such a strategy. It should make political decisions concerning the allocation of resources and the development of the service-structure more in accordance with empirical facts.

The main actors in service production units include administrative nurses, surgical nurses, home-help workers, nursing assistants, health managers, doctors, physiotherapists, ergonomics professionals, and psychiatric nurses. Moreover, both nursing homes and service production units in home care are geographically dispersed throughout the city.

At the administrative level were the following actors: 1) The Manager of Nursing Care (this actor was the driving innovative force and the entrepreneur behind the MIS); 2) The health care manager (a new leadership position due to reorganization in 1992, yet up to 1998 the same actor as the person who was the Manager of Nursing Care); 3) Project leader (a nurse manager who was assigned to the project of developing the MIS); 4) Administrative staff (economic, organizational, personnel) and 5) IT consultants. In addition, middle managers, system developers and IT-engineers complete the complement of players.

5. The MIS as an Ongoing Failure

The MIS was introduced during a period of comprehensive effort to modernize care services in the municipality. One actor, the Manager of Nursing Care, was the main change agent. Being a former researcher within geriatrics, he entered the scene having relatively clear and ambitious notions about "how to do it". He initiated several change efforts partly rooted in sector-specific ideas and partly in theories of NPM. These ranged from new organizational structures focusing on a goal-oriented delivery of services, to the introduction of management by objectives (MBO)1 and the implementation of nationally initiated health care

reforms. In a certain sense, he was a politician and entrepreneur, trying to influence both the actors at the grass-roots level and those elected by vote. But this mixture also made him a stranger with regard to the institutional values at work on the grass-roots level. He might be characterized as a translator of general ideas embedded in the on-going reform efforts, trying to make them materialize in practice. To accomplish this goal, he was dependent on the other actors in the field. They represented obligatory passage points through which the change initiatives needed to pass (Latour 1987). On the grass-roots level he managed to restructure the care services in such a way that he became the central point in the evolving actor-network. However, there were problems. The nurses felt that their dominant position as leaders of the care services was threatened. Other professionals, such as the physiotherapists, expressed "fear" of losing their professional autonomy. To strengthen his role, he initiated rather intensive interactions between himself, his staff, and the nurse managers in the districts.

The enabling role of the MIS was to produce statistical knowledge about the clients to be used in the effort to modernize the health care services. Further the MIS was constructed and tested out at an applied research institute. It was labeled the Main Card.

The MIS in its first phase turned out to be a failure, but a failure that did not die. We characterize it as an ongoing failure. Our interpretation is that it was too one-sidedly constructed to satisfy the interests of the top administration in their need for statistical knowledge. This is true despite the effort to include the actors from the service production units in the process of development. Neither unit leaders nor employees showed much interest in classifying the clients or putting the information into the computer. However, as an ongoing failure, relative to the expectation at the outset, it had entered the field symbolically achieving legitimacy. Thus instead of being an instrument to be used in the effort to modernize the health-care organization, it became a contested and resource demanding object of development.

5.1 Management by objectives and the Main card

The project MBO was highly symbolic in character. It was a discussion about the substantial values in the health-care services and was carried out with active participation by employees and managers in the service production units. It resulted in a written goal-structure both for the clients and for the employees. These goal-structures were used in operative planning in the service production units. On the other hand it was about producing hard facts about an objective situation.

1 The main characteristics of Management by objectives; The construction of a management practice in which the formulation of objectives and the evaluation of results are carried out systematically.

The MIS was constructed as a tool to produce such facts. Theoretically it was legitimized within the theory of MBO. The logic of MBO was mobilized, and an IT technician was hired to construct the system. Then the necessary investments in IT equipment were made and distributed to the different service production units in the different areas in the city.

There is decoupling in the sense that the development of the MIS and the MBO project went in different directions. The MIS turned into a failure while the MBO turned into a highly ritualistic process of organizational development. What actually happened was that the operative planning supposed to be linked to the effective use of economic and human resources became translated into highly qualitative improvement planning. Thus we can observe decoupling i.e. the effort to introduce operative planning in the service production units did not materialize. The hard fact of economics escaped the change effort! The MBO project turned out to be a highly symbolic change effort combined with the construction of a MIS which turned out to be a failure. How can we explain this?

One way to explain this on-going failure is that the potential constructive idea of the main card coincided with the visions of the reforms efforts that went on simultaneously. In our approach, reforms and the enabling role of IT are not only rational means to achieve stated ends. These ideas act as norms about what the world ought to look like and thus create a demand for solutions. Accordingly, although the MIS turned out to be a failure it represented an important solution symbolically. It represented, so to speak, a strong symbolic and material force despite its failure to produce reliable statistical knowledge. This ongoing failure is a kind of decoupling but this is an effect of the dynamics between the symbolic and technical elements in the process. MBO was a theory that was not rooted in the realities of health care. On the other hand the idea of the main card traveled to the national level turning into a project named GERIX which should develop a statistical program to be used nationwide.

6. Inscription of interests

The direction of MIS development changed when a nurse manager acting as a spokesperson got support for the idea that the MIS should be useful for the actors in the service production units. A new system should be constructed retaining its enabling role as a producer of statistics, but should be complemented so that it also could have an enabling role in the coordination of the production of services and professional planning. It was labeled NIT PRO. Thus in a very concrete sense we observe inscription of interests into the MIS.

After a complex process of technical construction the new system was to be tested out in a pilot project. The idea was that this strategy of introduction should be carried out throughout the organization. However, one problem was that the pilot project was too biased toward the technical dimensions of the system. Organizational problems arose, and conflicts between the

project leader and the participants led to a break down of this strategy of implementation. The effects were twofold: the technical closure of the system and a breakdown of the strategy of participation.

Two events in the pilot project are of particular importance in respect to our discussion. The project contributed to a refinement of the system. We interpret that as a technical closure. In that respect the project achieved its goal. On the other hand the strategy of participation was not successful. Tensions and conflict arose between the project manager and the participants in the service production units. The project manager quit her job because of all the consequent problems. She stated that such a project has to be managed through the ordinary chain of command. This resulted in a redefinition of the strategy of implementation. As we shall see later a top-down strategy was chosen.

In our view the relation between the technical closure of the system and the break down of the pilot project is a kind of decoupling. But again it is decoupling in the sense that it is an effect of the events in the process. It reflects the problem of integrating different logics, values and interests at work in the field. NIT PRO as a technological artifact so to speak needed a field to test itself. Such a practice did not exist. The service production unit in which the system was tried out had to elaborate new formalized routines which fitted the requirements of the system. This created conflict because the participants in the pilot project expected to influence the system so it matched their practice. Thus we have a problem that is both technological and organizational but is in practice treated as two independent elements. Our interpretation is that this is a process in which decoupling is occurring between the technical artifact as a representative of the administration and the organizational practice (in particular the nursing profession) at the grass-roots level. The actors' capacity to cope with problem of cooperation reached its limit.

In the wake of the collapse of the pilot project and the technical closure of the MIS, a top-down strategy was chosen. This change in strategy led to conflicts, which paradoxically strengthened the legitimacy of the system. The top administration used the dispute as an opportunity to get support for the system from the politicians. This was accomplished by going back to the initial idea of the need for statistical knowledge to be used in the decision-making processes. The politicians strongly supported this and the problematic situation was resolved. Moreover, it became legitimate to invest in a comprehensive educational program so the employees could learn to use the system.

During the period of 1997 to 2000, the MIS to a certain degree turned into an obligatory passage point in the delivery of services to the clients. About 200 workstations were connected to the server simultaneously. By producing statistics, it was also an element in a wider actor-network. It "settled down" in centers of calculation (Latour 1999) both on the local governmental level and through GERIX on the national level. However, there was only partial use of the system. The statistical data produced were used in a highly improvised manner and on an ad hoc basis. In spite of this, it is reasonable to say the

system was implemented on a large scale. Although still contested, it has become a necessity in the day-to-day activity of the service production unit.

The development of NIT PRO illustrates how different logics, values and interests are inscribed into the MIS. The actors at the grassroots level, when using the system for their own sake, now do the job of classification which is required for the production of statistics. The Main Card became GERIX, and its focus on the classification of the users and the production of statistical knowledge is now less prominent. It is integrated into the system of day-to-day coordination of service production and has a more invisible role. Actors at the grassroots level produce statistical data that are to be used primarily elsewhere. At the same time, they have an administrative system for their own use and these two functions are mutually dependent on each other. Thus instead of observing decoupling we observe a process in which heterogeneous elements are brought together. If there is decoupling e.g. the fact the nurses did not show any interest in using the professional planning module it is an effect of a process in which the symbolic and substantial are intimately linked. MBO as the guiding theory did not suit the interest of the nurses. We assert that decoupling is embedded in deep-seated assumptions about how the world is: i.e. organized action is classified within a substantial framework in which there is a dichotomy between the symbolic and the material. That they are linked is, within such a framework, difficult to comprehend. Instead they surface as problems to be handled but this occurs within the same dichotomized logic with the consequence that the problems persists or even is strengthened.

The alignment of interests is only partial. The administrative elements of the MIS have been put to use, but the way they are used is far removed from the original intentions. To get reliable data turned out to be a pervasive problem. The professional element was not used at all. The reason is that the professional practice is too far from the model of MBO inscribed into the software program. Moreover, that the surgery nurses do not use the system clearly demonstrates their freedom of action. It also demonstrates they have an autonomous legitimating base that is difficult to negotiate concretely with the administrative logic. Furthermore, we observe that the system, in addition to its enabling role, is starting to demand resources. During the process IT staff became established as responsible for the maintenance and improvement of the system. In addition to the resources spent on education a relatively large amount of labor-time is also used by the employee running the system in each service production units.

7. Radical organizational change

In 1997 it was decided to implement a new organizational model labeled the ordering-delivery model. It consisted of two main dimensions. Firstly: four service offices were established, geographically spread throughout the city. They are responsible for the diagnosis, design and decisions of services for

the clients when they apply (the ordering function). Previously the client went directly to the service production units. On their part the service production units are responsible for delivering services ordered from the service offices. Secondly this new model represented a radical break with the existing formal management structure. The number of administrative levels was reduced from five to two. One level consists of the service production units each of which is headed by unit managers. There are about eighty of these units. The other level is nothing but the top executive level. The underlying principle is that everyone either formally belongs to one of the service production units or if not, they are formally acting on behalf of the city manager.

Within this model the actors in the above-mentioned service offices are formally defined as independent units with a formal status similar to the service production unit, but they also act on behalf of the city manager. There is an ambiguity in this construction that arises because of the principle of only two levels. The service offices and the service production units are on equal footing, while at the same time they both have to act on behalf of top management within their own area of responsibility. Such a model opens up for power relation based on negotiation. Another consequence of this model is the proliferation of staff members or what might be labeled quasi-staff. The Health care manager acting on behalf of the city manager is surrounded by a huge number of consultants within economics, human resource management, planning and IT. Thus we observe the rise of a new structure in which the classical bureaucratic model to a certain extent has formally disappeared.

This new model was launched, i.e. formally implemented, with a lot of unsolved problems and challenges. Our interpretation is that as a radical new model it became an active element opening up the road for the further development of the MIS. Moving away from a relatively well-ordered and detailed administrative structure the order-delivery model introduces uncertainty and ambiguity. The new structure simultaneously creates zones of uncertainty and new opportunities for using legitimate power [Crozier and Friedberg 1980].

The project leader concerned with the maintenance and development of IT confirms that the establishment of the service offices turned into a demand for information for which NIT PRO became a potential solution. Specifically the actors in the service offices perceived the necessity for a communication device between themselves and the service production units. The ability of NIT PRO to produce information concerned with the documentation of the clients' needs and their level of functionality in the diagnosis, design and delivery of services was highly relevant.

A new health care manager came on the scene during this period. The IT consultant felt that this new manager did not see the potential in NIT PRO. "It was not easy to get support in this period", he said. This changed when an economic crisis arose. Those elected by vote demanded action to be taken to achieve economic control. This situation became an opportunity to launch the idea of using the client data produced in NIT PRO. Such an idea received approval and a joint project between the municipality and an IT firm came

into being. A software program was designed that could use the knowledge produced by NIT PRO in the estimation of the relative share of economic resources to be allocated to each service production unit. It is a prize-setting system based on the level of functionality of each client grouped within ten different samples.

As stated above, although NIT PRO was used on a relative large scale the quality of the documentation of the client's level of functionality varied. The problem seen from the position of the top administrative management was how to motivate or "force" the managers and employees in the service production units to do a thorough documentation to achieve high quality data about the client's level of functionality. The health care manager sent out a manifest that ordered the managers in the service production units to prioritize the documentation of clients. The message was complemented with sanctions stating that if the documentation were not done properly they risked losing resources. Thus an economic dependency relation is created. The new budget model i.e. the group prize-setting system is dependent on thorough client documentation at the same time as the service productions units relative amount of economic resources is dependent on the computer-based budget system. We are observing the development of a quasi-market. The MIS has allied itself strongly with NPM in which a new power relation is constructed between the administration and the service production units.

8. Discussion

Within neo-institutional theory, Meyer and Scott (1983) have introduced the distinction between technical and institutional environments. *Technical environments* refer to how organizations make products or services that are exchanged in markets and rewarded for effective and efficient performance. These environments foster the development of rationalized structures that efficiently coordinate technical work. In the purest sense, such environments are identical to the competitive markets. By contrast, *institutional environments* are characterized by the elaboration of rules and requirements to which individual organizations must conform in order to receive legitimacy and support. In institutional environments, organizations are rewarded for using appropriate structures and processes, not for the quantity and quality of their outputs. The fact that the health care sector is characterized by contradictory logics, values and interests makes the institutional environment highly ambiguous. However, the legitimizing base for the MIS has been an implicit desire to construct a system enabling management to compute the cost structure of service production and calculating demand in line with NPM. This is a process in which these two environmental characteristics are blurred. Given that we observe both coupling and decoupling we must explain how this comes about. Thus we move beyond the dichotomy between these to types of environments.

8.1 Decoupling in practice

NPM is a modern reform trend containing strong "rational" visions of the smooth running organization combined with implicit assumptions about an objective reality. Such an approach corresponds with the objectives of the MIS development in our case. Statistical facts about the service production should be discovered and put to use in a rational decision process. On the other hand because of this strong focus on the organization as an instrument to achieve efficiency and effectiveness in a technical sense the symbolic dimensions tend to be taken for granted. We argue that there is a kind of decoupling between the "symbolic" and the "technical" operating in practice. It is an institutionalized notion that such distinction exists and this has real effects. Our interpretation is that a certain dichotomy between the symbolic and the material has been a pervasive and to a great extent a tacit assumption in the MIS development. The Project: Management by Objectives illustrates such a dichotomy. On the one hand it was a highly symbolic mobilization of the employees focusing on the importance of identifying oneself with the raison d'être of the organization. From the point of view of the top management the process of making the goal-structure was considered important because the employee could be more conscious about what should be considered valuable in the service production.

On the other hand the MIS was based on an empirical and technical approach used in the name of technical efficiency. The Main Card was constructed as a tool capable of realizing such an objective and had its legitimating base in a quantitative social science method. The MBO project as organizational development was rooted in a phenomenological approach in which meaningful actors participated in the project. We have then two entirely different change projects gathered into one program of action. Firstly the value-discussion, which is symbolic in nature and secondly the computer-based statistical program that is highly material and technical. The theoretically formulated link between them was MBO. This theory turned out to be a failure because it was not sufficiently rooted in the realities of the health care sector.

NPM is negatively legitimated through a critique of bureaucracy. Positively it is legitimated as solutions contributing to a more rational and effective public sector. Although a highly materialistic approach it must also be considered a strong symbolic or discursive force. When ideas from New Public Management are translated into reform projects the symbolic or discursive dimensions are strongly at work in the arguments and the legitimating rhetoric embedded in the effort to make the reform materialize in practice. Observing discrepancies between intended and actual effects does not imply that change efforts do not have effects. We state that it precisely when we focus on the way the actors try to handle such a discrepancy we may gain a more in-depth understanding of MIS development. This implies that although we observe decoupling in the sense that reforms do not have the intended effects, we cannot conclude that they do not have any effect at all. This case demonstrates that the ongoing failure translated into a substantial change of the MIS i.e. different values and

interests were inscribed into it. But again we observe that the alignment of interests was only partial. The nurses were reluctant, the classification of the clients was imperfect. Thus the decoupling between the symbolic dimensions of the reforms was decoupled from the practical work of the service providers. But the MIS has turned into an active element in service production units representing primarily the interests of administrative management.

8.2 The construction of quasi-markets

This case illustrates how a kind of quasi-market is constructed and how the environment of the production of health-care services becomes more focused on technical efficiency. The MIS turned into an enabler when it allied itself with economics. We state that symbolic power is a necessary condition for this achievement. When NIT PRO became coupled with the new economic management system, the administrative management could order the actors in the service production to do a thorough classification. They threatened them with economic sanctions if they did not comply, turning the MIS into a powerful actor in the hand of administrative management.

This implies that new power games are emerging. Economic logics (relying implicitly on legal rational authority) become more dominant while the care logic to a greater extent (the sectoral values and interests) has to play the game of the administration. The MIS play a role both as a boundary-spanning object (Bowker and Star 1999) integrating contradictory values and interests at the same time as it is an active element in new power games which create the conditions for more strategic action in the service production units and a more direct form of economic management on behalf of the administration. The new power games in which the MIS is a prerequisite tightens the relation between the service production units and the administration in the economic dimensions. It appears to create a decoupling between the care logic and the administrative logic. If this is a reasonable analysis, we should expect crises to arise in which spokesmen of the care logic will express dissatisfaction and/or try to use the system for their interest. Paradoxically this implies that they have to talk about the economics of care which is highly illegitimate but real.

9. Concluding remarks

Using neo-institutional theory makes us sensitive to the power of institutions in MIS development. In this paper we have proposed to use decoupling not as a theoretical assumption that draws a dichotomy between the symbolic and the material, but as a contingent phenomenon. We have tried to illustrate both decoupling and coupling. The case demonstrates that the relation between IT and organizational reforms produces effects that may be both strongly coupled and decoupled. Our tentative conclusion is that decoupling is intimately related to the theories guiding the reform efforts. Based on a rational perspective

in which the symbolic and the material are dichotomized implicitly as two independent domains there is no way to reflect on how they are interrelated. A rational perspective is not aware of its own symbolic force. It is concerned about how to manage a material world efficiently and effectively. It is a theory that hides from itself that it at the same time represents a vision of how the world should be and a strong action theory about how to the world should be organized. People and technology are considered instruments in the hand of the "organization". The fact that an organizational practice produces outcomes that do not correspond to the implicit expectation of the rational model is not explained as shortcomings in the theoretical model. Paradoxically when unforeseen consequences, unexpected problems and surprises arise they tend to be coped with within the same theoretical framework. We may even go a step further and say that they are a necessary flow of events in the reproduction of the existing structure of domination.

We observe the emergence of new symbolic power relations (Bourdieu 1990) in which the MIS plays an important role. At the same time as economic logics become more dominant we observe a certain kind of decoupling of the sectoral interests. The relation between the MIS and the symbolic power within the framework of legal-rational authority creates new and strong power relations in which the administration get the upper hand. This should be investigated further. One interesting question is about how symbolic power is linked to the dynamics of legitimacy i.e. how it is taken for granted. A consequence is that it is hard to discuss. Paradoxically it works just because it is taken for granted. Given that, our interpretation of the story is reasonable we can conclude that the MIS has turned into an active element within the logics of NPM. What characterizes the process of MIS development is (1) a tight coupling between the symbolic powers exercised within the framework of NPM and (2) a decoupling between the care logic and the sectoral values and interests guiding it. By framing the process this way the distinction between the symbolic and the substantial has turned into a research object.

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Technology Implementation: A Qualitative Case Study of E-procurement

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***Abstract**: This paper reports a case study of a large multinational corporation (MNC) implementing a new technology for indirect procurement. Drawing on empirical data from five different plants and findings from multiple theoretical streams, a framework is developed to better understand how technologies can be internally diffused to disrupt existing routines. The proposed framework suggests that in order to better understand the process of technology implementation, researchers as well as practitioners, should consider (1) the underlying characteristics of the technology, and (2) the institutional context so as to understand what means should be used for influencing the process. The paper suggests that these categories must continuously be aligned, and thus, implementing large scale technologies, involving many users, should not be seen as an act but rather as a process of organisational change.*

***Keywords**: E-procurement; Technology diffusion; Behavioural routines; Technology implementation*

1. Introduction

During recent years e-procurement technologies have gained considerable interest from practitioners as well as from academics. This sort of technology is defined as any technology designed to facilitate the acquisition of goods by an organisation over the Internet so as to lower procurement costs, shorten purchasing cycle time and reduce number of suppliers (Davila et al. 2003; Gebauer et al. 1998). But in spite of the promises e-procurement holds, most implementing firms have not received the calculated benefits of its e-procurement investments (Davila et al., 2003), finding the implementation process as more complex, expensive and time consuming than originally expected (Conference Board, 2001). Still, consultants and market analysts are expecting tremendous benefits from e-procurement, though they have been

criticised for being overly optimistic (Conference Board, 2001).

Although great interest has been shown to e-procurement, the theoretical field is still underdeveloped (Neef, 2001), and it can be argued that we still do not understand the nature of e-procurement particularly well. Research to date has mainly been concerned with the market diffusion (Davila et al., 2003), transaction costs (Croom et al., 2001), or which tools to use (Gebauer & Segev, 2001). No studies have, to our knowledge, been devoted to intra-organisational issues, even though it is argued that one should not "underestimate the sweeping internal changes that e-procurement demands" (Purchasing, 2000 p.87). Also, the new technology implies a new working routine and an internal diffusion process, embracing several hierarchies in the organisation.

But even though it is important to understand 'routines' and 'intra-organisational diffusion' in relation to e-procurement the concepts remain largely de-coupled. However, couplings between other technologies and routines can be found. For example, some studies argue that technology strengthens routines (Gersick and Hackman, 1990), while others claim the opposite (Zuboff, 1988). Also within the 'diffusion' field, number of studies can be found treating technological innovations (Rogers, 1983; Attewell, 1992), yet only a few of these studies are dedicated to internal diffusion (Cool et al., 1997). But common for both of these fields are, when coupled with technology, the weak emphasis on the basic nature of the studied technology.

This study aims to fill this theoretical gap, investigating the basic characteristics of e-procurement technologies and its relation to internal diffusion as well as to routines. A world's leading supplier of commercial transport solutions, Volvo Group, was investigated.

The study is divided into the following parts. First, literature on e-procurement will be critically reviewed and put in relation to general e-business theory. The next section moves on to describe the concept of routines and internal diffusion. Then some methodological considerations will be discussed before entering the empirical case. When the case has been described, a discussion will follow, which finally ends up in the conclusions.

2. Searching for the underlying characteristics of e-procurement

For information technology (IT) in general and e-procurement in particular, efficiency is central (cf. Davila et al. 2003; Chan & Lee, 2003, Amit & Zott, 2001), expecting the technology to streamline existing business functions. Other rationales for e-procurement investments are opportunities to reduce the cost per item, reducing the time to procure the item (Segev et al, 1998), and to maintain established long-term relationships with preferred suppliers (Dai and Kauffman, 2001).

E-procurement is hard to conceptualize in a solid and unambiguous way. The concept of traditional procurement is described as "all activities involved in obtaining material and services and managing their inflow into an organisation toward the end user" (Segev et al, 1998 p. 11). Here, it should also be noted that it is estimated that an organisation spends more than 30% of their income on purchasing goods and services (Gebauer & Segev, 2001). Considering the huge number of activities as well as the vast amount of money included in the act of procurement, it is obvious that different organisations have designed idiosyncratic and socially complex routines for working with procurement. Thus, what the extra 'e' adds to traditional procurement may not only be ambiguous per se but also heavily dependent on the context it is used in. For example, smaller organisations may choose simpler e-procurement models, while larger organisations, investing more resources, will not only implement a web-based application, but also connect the technology with other business critical information systems, such as enterprise resource planning systems (ERP), electronic data interchange systems (EDI), or/and electronic invoices (Dai & Kauffman, 2001).

As a result of the all-embracing character of the term e-procurement, any attempt to give an unambiguous and specific meaning to the concept is doomed to fail. But in spite of e-procurement's broad, vague, and ambiguous nature, some basic yet unique technology-related characteristics of large scale e-procurement investments are salient: (a) lack of network externalities; (b) large number of users; (c) incessant inter-organisational interaction; (d) lack of a specific end-point; and (e) binary character when using the technology.

2.1 Network externalities

Network externalities means that the perceived utility of a good increases with the number of other agents consuming the same good (Katz & Shapiro, 1985). Many technological innovations are endowed with network externalities. Telephones, for example, are of little value unless other people also have telephones. Also e-mail or dateservices over the Internet would be useless unless other users were engaged. For e-procurement, in turn, users will not gain any extra utility no matter how many in the organisation are using the technology. Instead, the interaction among users is of an hierarchical level, e.g. a manager needs to approve the order from an end-user. However, the inter-organisational interaction, increasing number of suppliers and catalogues, involve network externalities.

2.2 Large number of users

As mentioned above, e-procurement technologies are expected to save costs through process reduction, i.e. redesigning existing procurement procedures. Such redesign could for example imply a removal of centrally controlled

procurement, distributing the work directly to the end-users. Thus, the work load will be decentralized, involving a great number of end-users.

2.3 Incessant inter-organisational interaction

Traditional procurement involves an incessant process of getting new suppliers as well as to weed out old inferior relations. The same goes for e-procurement. For example, most e-procurement software enables the end-user to either buy from a catalogue of goods, or to buy directly from a contracted supplier, and hence organisations must on a continuous basis spend much effort on contracting suppliers. This process is perceived by many large organisations, which intend to use e-procurement, as the major barrier to adoption, particularly since there is a lack of access to suppliers and a lack of investment in catalogues by suppliers (Davila et al., 2003)

2.4 Lack of a specific end-point

Orlikowksi and Hofman argue that "the changes associated with technology implementations constitute an ongoing process rather than an event with an end point after which the organisation can expect to return to a reasonably steady state" (1997, p. 12-13). Such a notation may also be consistent with large scale e-procurement investments; in particular if the large number of users and inter-organisational interactions are taken into account.

2.5 Binary

In many cases a technology is a tool which is supposed to replace another tool. For example, if an organisation changes a business system, the old system will be replaced and hence impossible to use. Idiosyncratic for e-procurement, though, is that new technologies such as e-procurement software will not replace old working tools. Instead the new technology will be a complement to other technologies such as telephones or regular e-mailing. Thus, users will always have the opportunity of not using the system.

3. E-procurement in use

To reach the fundamental rationale for implementing e-procurement technologies, i.e. increase efficiency (cf. Amit & Zott, 2001), the technology must be internally diffused throughout the organisation. Further, it must be integrated into existing procurement routines and disrupt old behaviour that remains from earlier procedures. Thus, to integrate the underlying characteristics of e-procurement with the organisational context, the process must (a) include a disruption of old routines, and such process must be underpinned by (b) an

internal diffusion process.

3.1 Disrupting routines

Repeated patterns of behavior are commonly referred to as routines (cf. Ashforth & Fried, 1988; Cohen & Bacdayan, 1994). For organisations, routines are an important element for increasing speed and efficiency in competitive tasks but they may also hamper necessary changes, ending up doing the same thing in different situations (Cohen & Bacdayan, 1994).

It is widely argued that organisations need to be adapted when implementing new technologies (Barley, 1986; Attewell, 1992). Thus, implementing new technologies may imply implementing new work practices, disrupting old routines. But routines may preserve artefacts of old technologies which can be problematic when using new ones (Cohen & Bacdayan, 1994). Tyre & Orlikowski (1994) studied three manufacturing and service organisations and found that users soon became routinised in their behaviour when engaging with technologies, and thereafter congealed in their use. Orlikowski argues that structures are not embodied in the technology, but rather enacted when users engage with the technology drawing on:

> "their skills, power, knowledge, assumptions, and expectations about the technology and its use, influenced typically by training, communication, and previous experience… Users also draw on their knowledge of and experiences with the institutional contexts in which they live and work, and the social and cultural conventions associated with participating in such contexts." (2000, p. 412).

Thus, structures and rules are not predetermined, but rather dependent on how the technology is used. Consequently, routinised behaviour is "constrained and enabled by the cognitive structures of individuals, such as scripts, as well as the physical and social structures of the organisation" (Pentland & Rueter, 1994, p.489). However, if the technology at hand is not used in a recurrent social practice, the user will not enact the structures which shape their emergent and situated use of that technology (Orlikowski, 2000).

If intended users are assumed to be engaged with the technology on different terms, this puts stress on how they learn. It is argued that when learning action-based procedures, which to a certain degree are stored in the procedural memory, calls for learning-from-experience (Levitt & March, 1988). The knowledge involved is too tacit and actioncentered to be communicated through documentation or other formal learning. Instead the actor is assumed to learn individually in a trial-and-error manner, exploring the technologies functionality through experimentation.

3.2 Internal diffusion

A common view within diffusion theory is that when enough individuals adopt the technology, and thereby interact, the diffusion will accelerate as an unstoppable epidemic (Rogers, 1995, Cool et al., 1997). A related term is here the 'critical mass', indicating a point in time where enough people have adopted the technology to ensure self-sustaining diffusion (Cool et al., 1997). However, the view of everyone having equal opportunity to adopt an innovation has been criticized (Brown, 1981). Further criticism have been put forth by Attewell (1992) drawing on Eveland and Tornatzky (1990), arguing for the importance of viewing diffusion as occurring within a certain context. Szulanski (1996; 2000) made similar findings when studying knowledge transfer, arguing internal stickiness of knowledge transfer to be primarily a result of: (1) arduous relationship between recipient and source; (2) low absorptive capacity; and (3) causal ambiguity. Consequently, diffusing technology might be sticky due to cognitive restrains. However, Kalling (2003) argues that motivational factors need to be in place first, underpinning the cognitive factors. Motivation might come naturally, but when not, managerial influence is needed (ibid.). This is consistent with Leonard-Barton and Deschamps (1988), arguing that some people will adopt naturally while others needs to be influenced. Some users may have personal interest, needs and skills, while others only perceive the technology as interfering with their daily practices (ibid.). Leonard-Barton and Deschamps thus argue that managerial influence is an important tool for engaging the non-favoured users, while favoured users will engage automatically.

A commonly stated factor for implementation success is top management support (Cooper & Zmud, 1988). Scarnati (2001), for example, argues that management needs to assert enough resources. Leonard-Barton and Deschamps (1988), in turn, emphasise management as influencing slow adopters.

Apart from top-management support, literature has also been focused on the team leaders' role; motivating and encouraging team-members, creating a high degree of trust among members, asserting complementary skills and preparing extensive project definitions and planning (Katzenbach and Smith, 1993; Edmondson, 2001; Ginzberg, 1979; 1981; DeSanctis & Courtney, 1983; Cooper & Zmud, 1990).

4. Summing up theory

Characteristics of e-procurement	E-procurement in use
Underlying characteristics	Disrupting routines
lack of network externalities	recurrent/occasional engagement
large number of users	motivation
incessant inter-organisational interaction	Internal diffusion
lack of specific end-point	managerial support

binary character	complementary skills resources trust formal preparations

Table 1. Important aspects when studying e-procurement implementation

5. Method Research Design

This study is qualitative to its character, with an aim of generating a descriptive and explanatory theory of the internal organisational changes associated with e-procurement technologies. The method is mainly inductive, giving a close correspondence between theory and data, whereby the emergent theory is grounded in the data (Glaser & Strauss, 1967; Eisenhardt, 1989). However, it is argued that approaching data free from any preconceptions is impossible (Alvesson & Sköldberg, 1994), and hence, the process may be more adequately described as abductive, i.e. an iteration between induction and deduction. Still, no theories or hypothesis were constructed prior to the data collection. Instead, the data determined what theoretical fields were adopted, and during this process, several theories were tested, but only the fields best corresponding to the empirical insights were kept. This process could be described as *pattern matching* (Yin, 1994), analysing the case using a preliminary framework.

5.1 Research Sample

The reported case describes the implementation process of an e-procurement system within Volvo Group, one of the worlds' leading suppliers of commercial transport solutions. In Sweden, where the technology is first diffused, 26 plants (plants run as profit centres) is about to carry through the implementation. Five of these were studied, not primarily selected to ensure representation of the population of all adopting plants, but rather to include sufficient variation to explore factors affecting technology implementation. The different plants were not characterized as successful or unsuccessful in their implementation process, instead every case was treated as a separate story. The reason was that every plant's implementation story differed from the others, and that different plants were situated in different stages of the implementation process. Also, their implementation success was interdependent, where some plants could learn from other plants' mistakes. Plants varied in size, but the sample constituted plants whose size was prominently above average and had manufacturing in-house.

5.2 Data Collection

The process of data collection encompassed interviews with all in all, 42

people, between April and September 2002. Interviews were unstructured and took from one hour to two and a half hours. In a few cases the interviews lasted less than one hour. Tape recordings were made and later transcribed. Also notes were taken during the interviews. The interview usually started with an open question of how the respondent first came across the project, then directed, depending on the respondent, to his or her role, the relationship to other people and groups, problems that evolved during the process and how the implementation had evolved over time. Statements were cross-checked with multiple sources to assess its reliability. The data collection process was divided into two phases.

5.2.1 Phase 1

To be familiar with the project as well as the technology, one of Volvo's partners, Frontec, was contacted for an introduction. During one day four people were interviewed, giving a rich picture of the technological difficulties, integrative challenges, and change management work. Then, a contact with the Change Management Team (CMT) was established and three people were interviewed during a two day session. This group was built to assist the change process associated with the technology and consisted of only one person from the beginning, but when realising the substantial challenges of disrupting old routines, the group increased and at the time for the study the group had grown to ten people. The contact with the CMT was important and maintained throughout the process. Often, they were used as one source for crosschecking data, and a continuous contact over telephone was held.

5.2.2 Phase 2

After having established a contact with the CMT in Volvo, five different plants around Sweden were visited, during a one month period. At each plant, six interviews were conducted at average, including at least two people from the project group, one representing the management and at least two users. One half-day training session was attended, together with seven new users.

5.3 Data Analysis

The empirical data was analyzed according to familiar approaches for analyzing qualitative data (Glaser & Strauss, 1967; Miles & Huberman, 1984; Eisenhardt, 1989; Yin, 1994). Data from the initial interviews was important for initiating categories, properties and relevant concepts. These initial concepts were important when entering the field. Data was analyzed during plant visits, and categories and concepts were constantly refined, retained or abandoned. Thus, the analysis was first analyzed within the specific case and later related to insights from other plants. When new categories emerged, extensive

readings were done to get insights into that specific field. This allowed for a broad theoretical base, where observed data guided the theoretical directions. Several theoretical fields have been examined during the process, whereas only a few remained to the end. When all data was collected, the most important constructs were kept and used as a base for writing a narrative of the implementation process. In turn, the construction of the process model was the base for integrating the most salient findings into one coherent explanatory model.

To assert reliability, important categories and conceptual constructs were crosschecked with multiple sources. Usually, with only a few exceptions, there was a high agreement between respondents over critical issues. Here, the CMT played a crucial role as verifier.

6. The implementation journey

6.1 The decision to adopt

Volvo had for a long time perceived problems with their procurement routines and of particular interest was the procurement of indirect material, which later led to the creation of NAP (Non-automotative products), a central organisation responsible for all indirect procurement. This was a service that every Volvo plant could exploit and depending on their need, a number of people from NAP came to help the local plants. After a while, NAP became more and more interested in the possibilities of using technology as a tool. At the same time, on another location, a project of automating invoices grew, and finally the two projects grew into one project with the same name: move.on. People from NAP wanted an overall procurement solution, but they had to surrender due to the high costs involved. Instead, a web solution was chosen – a Commerce One product called EBD (Enterprise Buyer Desktop). Such technology works in the following way:

Every user that was categorized as a buyer had a login and password to enter the web-interface. When entering the system, a shopping cart could be created where different items could be added. Items could be searched either from a catalog, or from a free text search. Orders from suppliers included in the catalog were the easiest and fastest way to purchase. Placing orders from the free-text search, on the contrary, was circumstantial and often time consuming. When the shopping-cart had been concluded it was sent to the immediate manager, to be verified, and in some cases (when it was a free-text order) it had to be verified by a professional purchaser. Every firm's management was encouraged to set spend limits for the different users, and in those cases the orders did not have to be verified by anyone.

However, the technology was chosen by top-management, and thereafter a decision was made by the group executive board to adopt the technology. After the decision to adopt the technology and diffuse the technology around in the organisation, all plants had to walk through the same process.

6.2 Process View

To better understand and closer examine how events evolved and emerged over time, a process approach was adopted. Qualitative data, in combination with theoretical synthesis, suggested that the implementation process consisted of four discrete activities: initiation, adaptation, training and use. The described phases occurred chronological the first time, but later changed its character to an ongoing iterative process. The plants will be referred to as plant 1, plant 2, etc.

6.2.1 Initiation

The initiation phase starts with the decision to adopt the technology. Three factors determined the perceived degree of difficulty in the first phase: (1) the status received from general management, giving the project group either a generous or thrifty budget,

(2) the composition of the local project group, and (3) top-management support. The status received from the management clearly affected the composition of the project group. For example, at plant 1, where the project received strong management support, the project leader had free hands to choose his team. The same scenario was found in plant 2 where the management perceived the project as large and complex and hence needed high status. With the management's support and understanding of the project's complexity, the motivation grew among the project participants, and especially for the project leader. She commented: "The relation to the management is good. I haven't had any problems at all. Nothing. They gave us free hands".

In contrast, plant 3's management appointed a project leader - whose time was scarce to select her group participants. The selection process was restricted and the project leader was not allowed to include all members she requested. The project leader commented: "I wanted a larger working group with more people, but I was restricted. They wanted to minimize the time taken from other activities." The slow start was accompanied by additional problems where the low status of the project infected the rest of the group. It was impossible to gather all group participants for meetings and as time passed, the project leader stopped reporting to them. The project leader was very dissatisfied with the situation, claiming that the budget she disposed of never would be achieved if not the management changed their attitudes.

Top-management support turned out to be important, especially for the general management. A general manager at plant 2 commented: "It is extremely important that the decision is taken by the top-management. Several attempts to different projects have been made on corporate level, so it's extremely important that the decision comes from the top". One general manager even claimed they would never have adopted the technology if it would not have been for the pressure from the top. People from the project groups, on the other hand, were less enthusiastic about the fact that the decision came from the top-management. A project member reported: "It's important so far as it is hard to reverse such an initiative. But then, I may think that this project is not connected in the reality."

6.3 Adaptation

The adaptation phase started after the formal project group was formed, preparing the organisation for implementing the e-procurement technology. Included in the adaptation phase was (1) to build a buying organisation (BORG) – a sketch of the organisation's different cost centers, (2) establish roles for the intended users, and (3) examine existing authorization rules. Two factors determined whether the process was perceived as difficult or not: (1) design of procurement function and (2) group collaboration.

At the time for implementation the different plants within Volvo, all used different systems and procedures for purchasing indirect material. One consultant from the Change Management Team (CMT) described the situation: "We are 26 plants in Sweden, and they all use their own way of purchasing, so there are no common routines, throw out a set of spillikins and that's how it looks today". All plants were urged to undergo an inspection of their procurement routines after they had established a project group - a process that was perceived very differently between the plants. For example, at plant 2, the project leader was new and as a means to both increase the general understanding of the internal purchasing routines and to familiarise the project leader with the organisation, an extensive pre-study was carried out. Simultaneously as the preliminary study was realized, the BORG structure evolved. The task demanded great amounts of time, but the effort was well worth it, both as a means to strengthen the project group, but also to straighten out problems that later would have emerged.

In contrast, other plants had poor knowledge about their existing procurement routines. For example at plant 3, the project leader was brought face to face with a tough task when realizing the BORG structure. She described the situation: "I didn't know it was going to be so difficult to make a BORG structure. The disappointment was great when I went to the staff department to get an organisation structure and it turned out it didn't exist. I had to do it myself".

Even though the management did not have a formal role in the adaptation

process, they still influenced the stage, setting bounds to the project group. For example, at plant 5 the management was afraid of loosing control. One man from the project group explained that " The management decided that every superior had to approve a purchase, a rule that results in delay if the superior is away." When asked if management had gone from giving more reliance, to giving less, he answered: "yes, you can say that". The fear of loosing control was also observed by the CMT, a consultant described the situation: "When you are out [in the organisation], you face a fear, people [referring to general managers and other local managers] don't trust that the individual at the bottom of the organisation tree can take its responsibility".

6.4 Training (learning-before-doing)

When plants considered themselves as done with their preparations, they were urged to start the training session. This was a major process since some plants intended to have more than 100 users activated in the system. The formal classroom training, supplied by the CMT, was the same for all intended participants. One instructor was sent out and held a half-day training session. The interviewed participants were generally happy with the training session which increased their confidence, but felt that they needed more sessions. As a woman, attending the course, reported outside the classroom: "This felt great. Now I need to sit down in peace and quiet and work it out myself". Also, others reported that the training gave them a safety to continue using the technology.

What characterized the training stage was determined by two factors. First, the established status of the project was important for the attitudes among users. In some cases, the training sessions were reported by a regular e-mail message. Communicating this way made users perceive the training, as well as the project as whole, as something unimportant with low priority. In other cases, the training session was communicated very ambitiously. The project leader on plant 1, for example, personally told all intended users that they would soon attend a training session, so as to create a commitment and feeling of importance. Another effective way to spread the message of the project, which was adopted by only a few plants, was to present the project officially, for example in an internal paper.

The second determinant of the training session was the role of the project leader. It turned out that many users appreciated the presence of the project leader when undergoing the formal training session. For example, the importance of the project leader became evident during one training session at plant 1 when a man started to influence his friends in a negative way. The trainer, a consultant from CMT, described the situation: "you could already in the morning depict who was traveling in his car. Later on, you could see who was eating lunch with him. That training session got out of track due to that person." The project leader reacted very hard, and tracked the persons who was involved and solved it with them personally. The personal interaction between

the project group and users was important. Similarly, at plant 4, the project leader felt a great importance in establishing good relation to the intended users. He attended all training sessions in person, with the conviction that "it is important to show your face". Simultaneously, as the training was in progress, he tried to build rationales among the users, repeating the mantra of reducing number of suppliers.

Even though all participants were supposed to take the formal training, many never had the chance to appear, and were reduced solely to learning-by-doing. Why there were not more formal training was not clear, but CMT's lack of time and inefficiencies in communication affected the delays.

6.5 Use (learning-by-doing)

The use stage begins when first using the technology, i.e. when the user makes an order the first time. What impacted the stage of use was (1) the degree of learning before doing, (2) the individual's idiosyncratic preferences (whether the technology suits the person's individual interests and needs), (3) whether they were recurrently engaged or not, (4) social context and (5) managerial engagement. At the time for start-up the user had not necessarily been taking a training session, and was in that cases solely referred to learning by doing. An example was the early pilot group in plant 2 who were among the first to be trained. One participant wasn't too satisfied with his training. He explained: "I had the honor to take this training and when the teacher showed the system it functioned well, but when we were about to practice, the system crashed. So the training session was quite of a failure, you can say". Instead the department had to learn the system themselves. Fortunately, they could work it out together, learning from interaction with their colleagues. However, the interaction was only within the specific departments, not between them. For example, at plant 5, where one department had one representative in the pilot group, the technology was successfully diffused. Next door, where another -very similar department -was located, the technology had not been diffused at all. Thus, the social context was of great importance for the diffusion, but closed – with clear demarcations to other departments - in its nature.

It was evident that those who had purchasing as a central part of their work, and did not perceive the technology as interfering with their daily work, also used the system more frequently and effective. The same system was however used by everyone, even though their purchasing procedure clearly differed, suiting someone buying office equipment better than someone buying rare tools for a specific machine. Common for all interviewed users was that they thought that the CMT underestimated the differences among the different plants, but also between departments. One user whose work was not favoured by the system meant that the system was developed by those who sat "twelve chairs away from the reality."

Among the current users, rationales for using the system varied. Most of the

interviewed people thought the new system saved money, but no one had seen any evidence for that, and for some it was hard to believe that was the case. Or as one experienced user commented: “It’s wrong to say that you save money by reducing purchasers, because what they have done is just a transfer of work, from them to us”. Some of the more recurrent users, however, were not very interested in the marketing going around. A frequent user reported: “After all you want the system that works well, not the system that has been pushed out well”. But many users, particularly those less intensively engaged with the technology, were heavily influenced by their immediate superiors. A member of the project group stated that “immediate superiors are also important for motivating. If the superior is against it [the new system], you [the end users] don’t think you have to learn it.”

One of the major impediments for the disruption of old routines was that, even though the technology was implemented and worked sufficiently, the old tools, such as the telephone, still was present. An experienced consultant described the difficult task: ”The difference between this sort of implementation and an implementation of SAP/R3, is that the system is binary. The day you have implemented R/3 you cannot use the old system. But if you implement an e-procurement system, you can still pick the phone and call. So in this case you need to penetrate people’s minds somehow. It’s an incredibly greater work of change in total.”

7. Case Summary

Initiation	Adaptation	Training	Use
Status received from management	Design of procurement function	Received status influenced by user’s attitude	Learning before doing
Work-group composition	Group collaboration	Project leader’s engagement	Social context
Complementary skills	Trust		Individual idiosyncratic preferences
			Technology management
			Managerial engagement

Table 2. Key factors influencing the implementation process

8. Discussion

The case shows how difficulties evolved over time during the implementation and how the different plants reacted to emerging situations. The implementation process will, in this section, be closer examined, first from a technological perspective, and thereafter related to work on both routines and diffusion processes.

8.1 The Importance of Understanding the Underlying Characteristics

It is important to investigate the underlying characteristics of a technology to better understand the technology when set in its context, i.e. using the technology (cf. Eveland & Tornatzky, 1990; Orlikowski, 2000). Figure 1 shows the salient characteristics of the three categories: e-procurement's idiosyncratic characteristics, e-procurement in use, and means to influence the process. It is shown that the implementation process is influenced by the characteristics of e-procurement technologies. Starting on the top left side of the figure we can find specific characteristics of e-procurement technologies. First, e-procurement technologies imply an *incessant interplay with inter-organisational parties*, affecting the adaptation phase. This forces the organisation to constantly align the technology with the inter-organisational parties, adding new suppliers into the system as well as to weed out obsolete ones, so as to fulfil all plant's individual needs.

Second, e-procurement investments imply *large number of users*, and many of them will only engage occasionally with the technology. Since users only recurrently engaged with the technology will enact structures and rules for using the [illegible] are more importan[illegible]rs, seems to be m[illegible] sense of motivatio[illegible]

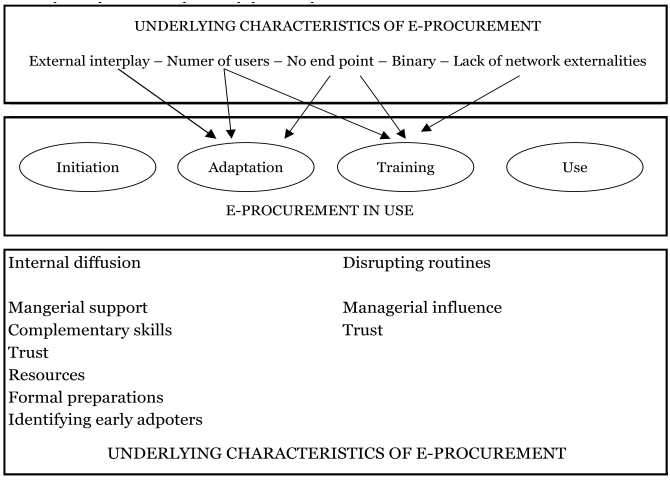

Figure 1. The process of implementing e-procurement technologies

The large amount of users also has consequences for the adaptation phase. For example, if some units are re-designed, this may cause changes in the procurement routines, where new people are assigned new roles. Physical changes in the organisation must be met by structural changes in the Buying organisation (BORG). And consequently, a continuous co-alignment between the technology's inherent structures and the organisational structure will emerge.

Third, and consistent with Orlikowski and Hofman (1997), the case suggests the technology implementation to be an *ongoing process* without an end point. The large number of users in combination with the inter-organisational interaction, will imply a constant alignment between the e-procurement system and the organisation. Moreover, to replace all systems with only one unified system may be problematic. Ciborra (2000) argues that building large IT infrastructures increases the connectivity, and as many infrastructures are linked to each other, side effects from underlying infrastructures may cause serious side effects to the infrastructure as a whole.

Fourth, technology is assumed to replace an existing technology. E-procurement on the other hand, does not replace an existing system but is rather a complement to existing ones, i.e. *binary*. In that respect, the user can, the day the system is installed, still use his phone to purchase. These characteristics are interesting when studying the use stage. The case indicated two interesting effects of the binary character of the technology. First, some people lacked in motivation since they knew that they could use old working routines, and as the new system often were more time consuming, superior managers had a hard time giving convincing rationales. In some cases superior managers even allowed people to use other means for purchasing, although the system should have been used. Secondly, other mediums such as telephone and fax were used in combination with the system. For example, several users from different plants used the fax and telephone in combination with the system. This indicates that the system's malleability is not restricted to the technological artifacts, but also to other tools that can be used as complementarities.

Finally, empirical findings pointed on the *non-existence of critical-mass*, where the diffusion stopped after reaching a certain point. It has already been noted by Rogers (1995) that critical mass is most important for technologies endowed with network externalities. Also this characteristic gives implications for using the technology. When the interaction among users adds value, the technology may be self-sustained after reaching critical mass, but when this benefit is absent, the technology can not be assumed to be spread on a self-sustaining basis. Furthermore, it was evident that people that worked close together, for example sitting in the same room, developed similar using techniques, while people on other plants, developed their idiosyncratic procedures. Thus, the

low interaction among users gives several implications, not only hampering the automatic diffusion process, but also holds back the possibility of learning from each other.

8.2 Diffusion theories

Within internal diffusion studies, the identification of *early adopters* (cf. Rogers, 1995; Cool et al., 1997), *team spirit*, and *top-management support* (cf. Higgins & Hogan, 1999; Edmondson, 2001), have been stated as important. For implementation success in general, *formal preparations*, have also been stated as an important issue (cf. Cooper & Zmud, 1990). Starting with the importance of early adopters, this case study also indicates that influential people were important as opinion leaders, affecting their colleagues. Interestingly though, was that opinion leaders seemed only to influence people within their own departments, and thus, there were strong impediments for transferring the technology between departments. For example, at plant 5, the diffusion had slowed down and findings indicated that there were barriers between different departments, and hence *no learning-from-others*. Most interviewed users showed small interest in teaching someone outside the department. These findings suggest several implications. First, it indicates, and as earlier noted, that the technology lacks network externalities, not spreading on a self-sustaining basis through user interaction. Secondly, it supports arduous relationship between source and recipient as a major impediment for technology transfer (cf. Szulanski, 1996). Consequently, considering the arduous relationship between source and recipient along with the lack of network externalities indicates that the innovation will not be diffused as an infectious epidemic. Instead, the diffusion may be hampered and slowed down if not the departments learn from each other. Lacking critical mass in combination with arduous relationship between recipient and source, thus, (cf. Szulanski, 1996) puts extra stress on managers to actively counteract stickiness.

Formal preparations were also perceived as important, although the process followed a more improvisational model than a clear and unambiguous plan (cf. Orlikowski & Hoffman, 1997). However, extensive project-planning were continuously made by the central CMT so as to align the formal part with unanticipated and emergent events. For individual plants, on the other hand, the formal preparations as well as the design of the procurement functions strongly influenced the adaptation process. Those plants with well-designed procurement functions, structured and well documented rules for purchasing, showed considerable advantage over those who had autonomous layered and subtle structures. Other initial conditions, such as size and economical situation were not proved to be important, even though it was indicated that a

good financial situation facilitated a generous budget.

Other factors important for the diffusion, recurrently stated in team-work literature, are *lack of resources*, *lack of trust* and *ineffective communication*, (cf. Scarnati, 2001). Plants having these inefficiencies, showed vast difficulties setting up appropriate project groups. Moreover, since the project encompass many different hierarchical levels within the organisation, the ineffective communication hampered and slowed down several processes. Many general managers, for example, perceived the project as small, seeing it as a low status project, and hence not giving any efforts of spreading the messages coming from the project group. Such ignorance made the work of the project group very hard, especially since many of the lower managers, crucial for persuading end users, rather listened to superior managers than the project group.

Also, the role of the project leader was stated as extremely important for all investigated plants. This is consistent with Edmondson et al. (2001) arguing for the implementation leader as important throughout the process, where the successful project leader is distinguished from the unsuccessful due to his/her ability to motivate and engage the co-workers.

Top-management support seemed to be of particular importance in the initiation phase. All general managers as well as most project leaders stated the top-management support as extremely important. Interestingly, though, was that top-management support was not perceived as important for the end-users, whereas it was important for initiating the project, a stage where general managers and project participants had more prominent roles. Still, even though end-users not directly called for top-management support, they were affected indirectly. For example, top management influences the general management around different plants, and in turn, general management was important for influencing lower managers which in turn is important for the end-user. As described in the case, several project groups claimed that the general management failed in influencing their subordinates, and thus, many project leaders had to put in unnecessary efforts for persuading the end-users.

8.3 Replacing Action-Centered Routines

Research in psychology (see for example Squire, 1987) and later in organisation theory (Cohen and Bacdayan, 1994) has proposed routines to be hard to access. Replacing old working routines, using technologies that involve many occasionally engaged users, may be problematic when considering the engagement to be of a more deliberative and conscious character rather than tacit and inarticulate. Thus, establishing new routines requires frequent users, preferably acting within the same institutional context so as to learn from each other. But since many IT projects, particularly large scale e-procurement investments as studied herein, imply many users only occasionally engaged with the technology, establishing new robust routines are difficult. Considering

these difficulties gives implications to this study, as well as for IT studies in general.

First, people will interact differently with the technology depending on the amount of tacitness involved in the act, and hence, people only occasionally engaging with the technology will do it in an articulate and deliberative manner, while frequent users engage in a more inarticulate way. Many of the interviewed, particularly the less experienced, explained the act of purchasing as a learning process taking place every new time they had to place an order. In that respect the technology seemed to, due to its complexity, increase the deliberate and conscious action compared to traditional action-based routines, particularly for those only occasionally using the technology. These findings give consequences on how managers and other opinion leaders should engage with the end-users, i.e. how they should act during the use-stage. Users, recurrently engaged, should have the opportunity to individually shape its structures and procedures from the technological artifact, while infrequent users, to overcome the high knowledge barriers, are in need of motivational incentives. Among the users not favoured by the new e-procurement system, there was a great disappointment and, interestingly, most of them called for sympathy from higher level, suggesting that if the general management, the project leader and the CMT understood the aggravation of their situation, it would work as a good motivator. Top-management support, however, were not perceived by any of the interviewed end-users as important.

Secondly, distinguishing between recurrent and occasional users calls for multiple learning techniques, and hence, gives implications to the training- as well as use-stage

(i.e. learning-before-doing and learning-by-doing). The case study indicates that more frequent users underwent a different learning process than those who were infrequent users. Frequent users - whose associated knowledge was more of a tacit nature and not fully articulated – learned through action rather than words or documentation and hence more independent of its learning context (see Zuboff, 1988). Infrequent users, on the contrary, who did not perceive the system as valuable, seemed to demand more formal training as well as motivational incentives than experienced users. Findings that formal training was perceived as important were not surprising; remarkable though was that many infrequent users needed to build up a *trust* towards the system before they dared to use it alone.

9. Conclusions and Future Research

Although vast attention has been devoted to IT implementation during recent years, few works, if any, have been focused on the specific properties inherent in a specific technology (cf. Orlikowski, 2000). This paper, in contrast, takes the idea of technology as a focus to illuminate the linkages between the

process of internal diffusion and disruption of routines on the one hand, and the technology's inherent categories on the other. By exploring these relations, we have developed a framework that constitutes the underlying characteristics of e-procurement, the implementation process and means for influencing the change process. It is argued that the concept of technology is an ambiguous entity inhering different categories which are intrinsically linked to social and cognitive challenges. It is argued that different technologies comprise different categories who give different socio-cognitive impacts during the implementation. For example, anecdotes of earlier technology implementations were constantly told by the respondents. General managers often referred to the relatively smooth implementation of an SAP R/3 system, and used this as an excuse for not investing more money. Other groups, working closer to the project, constantly highlighted the difference between this system and the SAP R/3.

This study, by investigating how a certain technology has socio-cognitive impacts may give complementary explanations to why many e-procurement investments have failed financially. Considering the difficulties of establishing new effective routines, for example, indicate that many users will engage occasionally, involving deliberation, and hence the process will be more time-consuming. Furthermore, since many of these users will not engage voluntarily, a great demand will be put on managers on different hierarchical levels. Consequently, taking into account, not only the time of ordering, but also on communicating, persuading and motivating, suggests that the process requires vast attention and time, involving numbers of people from several hierarchical levels.

Consequently, the complex and unpredictable nature of e-procurement investment calls for more flexible innovative change processes, similar to what Orlikowski and Hofman (1997) called an improvisational change management model. Managing such process also calls for not seeing people as emotionless, static people, but rather as individuals who, due to different needs and aims, will use the technology's functionalities and properties differently. The manager's role must therefore be flexible and improvisational, and carefully adapted to support the end-users' cognitive and social idiosyncrasies.

The empirical findings of this paper are, of course, limited to the specific context being studied. Thus, propositions and findings of this study may be contradicted if studied in other settings. This is the disadvantage of using only one case, but as the result should not be over-generalized nor should it be perceived as exceptional and marginal. The case being studied was a large, international manufacturer of transport solutions, an organisation that refers to traditional business settings, and plants within the organisation were selected to give sufficient variation. Still, field studies in different settings, either studying e-procurement technologies or other technologies presenting similar challenges, is required to validate the model and test the propositions. But, as the e-procurement phenomenon is something of a novelty, we believe this case study makes a contribution by means of the theoretical framework, taken

from technology implementation and knowledge-centered theories, along with the in-depth empirical field study. Our aim is not statistical generalisation but analytical (Yin, 1994).

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A Key to Success in SPI – Mapping Stakeholders' Success Criteria

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***Abstract**: Software Process Improvement (SPI) has been an established research area for more than 15 years. Many software organizations have implemented SPI in the attempt to heighten the quality of their software products. Some of them have succeeded and their experiences have become the field of study for many researches. However most of the studies avoid or do not explore the definition of success within SPI. One can argue that SPI programs can be perceived as successful if the formal goals are met. This paper argues that one definition of success is not sufficient. Success must be regarded as several dependent variables that can be evaluated against a set of success criteria derived from the involved stakeholders of SPI. Based on a literature study we have developed a theoretical framework - The SPI Role Matrix – used for analyzing the empirical data to facilitate exploration of SPI stakeholders' success criteria. The paper explores the multiple dependencies among goal, success and success criteria. The purpose of this research is to stress the importance of understanding SPI stakeholders' success criteria. This can help SPI project managers to choose an appropriate strategy to achieve success for all involved partners.*

***Keywords**: Software Process Improvement, Success Criteria, Stakeholders*

1. Introduction

Many companies turn to Software Process Improvement (SPI) to heighten the quality of their software products. The industrial interest for this software developing paradigm has grown rapidly within the last years. In the previous years European companies have had a preference for standard specifications,

typically the ISO series. But this tendency is shifting towards focus on processes. In Scandinavia, companies have begun to open up their eyes for this process-oriented approach to software development. Many reasons can explain this shift in attitude towards maturity and capabilities which is the center of the process-orientation. Beside the business-related motives, a reason for pursuing a process oriented maturity model is the continuing strife for improving existing practices to meet the business needs.

Software Process Improvement (SPI) is essentially about learning how to do software developing activities in a more effective and efficient way. By institutionalizing the processes in the organization it is the overall goal to improve the quality of the products by focusing on process optimization. Improving quality by focusing on processes is a demanding task for any organization that requires full commitment from all stakeholders internal as well as external to the organization (Chrissis 2003, p. 423, Zahran 1998, p.89). Adopting the underlying paradigm of SPI is quite an effort for immature organizations governed by ad-hoc decisions. Given the complexity of implementing and aligning SPI with the business goals of an organization it is not surprising to experience that many improvement activities have been reported as failures.

The idealized representation of the progression of capabilities and the corresponding processes depicted in maturity models fail to give a true impression of the complexity of the introduction and institutionalization of processes in a human context. This mechanistic impression is contrasting sharply to actual problems in the real world. Though for example CMM is originally thought of as a road map for process improvement, we cannot neglect the fact that the implementation of the processes affects human activities – the models revere processes but ignore people (Bach 1994). Common process thinking across group of individuals and the alignment of behavior and activities towards a common goal (Zahran 1998, p.4) is a very difficult objective to achieve. The involved stakeholders might simply have different motives for supporting the SPI project and thus diverse intentions.

SPI is an ongoing effort to achieve improvement in the software process and align the organization with new requirements concerning how products should be developed. The success of SPI implementation is dependent on a well-formulated strategy, clear statement of goals and objectives and a carefully prepared implementation plan (Mathiassen 2002, p. 27). These demands are met if the organization chooses to unroll the SPI as a project which have access to own resources. This formalization allows much more visibility in the organization contrary to a bottom-up approach lead by a single champion.

The accomplishment of an SPI project is dependent on the acceptance and the participation of the different business units as well as persons with key roles. For this very reason it is paramount to devote time to work with stakeholders' attitude and commitment to SPI projects (Mikkelsen & Riis 1998). To meet these demands it is important to acknowledge that many stakeholders participate in the improvement process, and hence many success criteria are in play at the

same time. With this in mind it is not fair to always determine the success rate of an SPI program based on the overall formal goals of the project. One must include all stakeholders and verify if their individual success criteria are met.

The objective of this article is to define stakeholders and their individual success criteria in relation to the realization of SPI. Instead of focusing on the formal goals, we will analyze the different involved stakeholders' expectations to SPI. In this way it is our ambition to give a more comprehensive and critical review of the involvement of different stakeholders in SPI, and thus aiding the project manager who typically is in charge of handling the relations and interests of the different involved stakeholders.

2. Success

According to the Merriam-Webster dictionary success is: "a degree or measure of succeeding" or "a favourable or desired outcome. "

To us this definition implies two things:

- That it can be measured in one way or another. One can thus succeed more or less according to some ideal.
- A desired outcome is always in the eye of the beholder - hence is success.

The quest for defining the dependent variable – i.e. IS success - has been on the agenda in the IS community for over two decades, since Peter Keen in 1980 at the first meeting of the International Conference of Information System (ICIS) identified it as one of five issues in need of being resolved (DeLone and McLean, 1992). The reason for this being that if research is to make contribution to actual practice, a well-defined outcome measure(s) is essential (DeLone and McLean, 1992). The evaluation of IS practice, policies and procedures requires an IS success measure against which various strategies can be tested; otherwise research will be purely speculative. However success and failure are not easy concepts to define and measure (Garrity and Sanders, 1998). There are potentially many levels of analysis: organizational, project and individual, and there are interactions between each.

As mentioned in the introduction software process improvement has been a buzz word in the software industry for some years now, and many have undertaken software process improvement initiatives, but with varying results. Consequently a growing number of studies are focusing on factors contributing to SPI success (Dybå, 2000; Goldenson and Herbsleb, 1995; Wilson et al., 2001; Rainer and Hall, 2002). However a review of the literature studying the dependent variable – SPI success – reveals that the authors' definitions of the term are at best elusive but often not explicitly present.

Dybå (2000) has identified nearly 200 prescriptions for success reviewing

quality management, organizational learning and software process improvement literature, however fails to specify what constitutes a success, whilst El Emam et al. (2001) speaks of SPI success but never defines what is meant hereby. In other studies SPI success seems to be connected to better performance with respect to product quality, staff productivity, ability to meet budget and schedule commitments, customer satisfaction, and staff morale and job satisfaction but it is never stated explicitly (Goldenson and Herbsleb, 1995; Stelzer, Taube, 1998 (in Steltzer and Mellis, 1999)).

Thus an implicit definition of success in many prior studies might be as defined in Paulk et al.'s (1993) Capability Maturity Model for software, Version 1.1 which states that the intent of software process improvements, and thus the measure for success of software process improvements, is improving the software quality, increasing the productivity, and reducing the product development cycle time.

In order to get more perspectives on success we turn to IS literature in general. Here we find that a large number of studies have focused on IS success and factors contributing to IS success, but different researches have addressed different aspects of success and thus no common denominator for the dependent variable for IS success exist. Assuming that researchers have chosen their dependent variable with great care, the fact that so many different measures were chosen is evidence that some diversity in measures is simply needed (Seddon et al., 1998).

In 1992 DeLone & McLean (1992) set out to organize the diverse research on aspects of MIS success. The output was a comprehensive taxonomy consisting of 6 different IS success categories based on an extensive literature review. The six being system quality, information quality, system use, user satisfaction, individual impact and organizational impact. In 2002 DeLone and McLean revised their highly popular model to include the concept of service quality, altering system use to Use (Intention to use) and collapsing the individual and organizational impact categories to one general net benefits category. However maintaining their underlying assumptions from 1992 arguing that researches should systematically combine measures from the categories presented in measuring IS success.

In contrast to finding "the" dependent variable or DeLone and McLeans (1992) reduction of the multitude of different measures into six categories, Seddon et al. (1998) argue that this diversity in measures is not a problem but rather that different sharply-focused measures of IS effectiveness are needed for different purposes and different contexts in a world of conflicting human interests and vastly different systems. One needs to take account of the context in which IS effectiveness is being evaluated. Seddon et al. (1998) argue that researches should always take care to identify both the specific system being evaluated and the stakeholders in whose interest the evaluation of IS success is being performed because even slight differences in stakeholders' perspective can produce significantly different evaluations of the system. Consequently Seddon (1997, p. 246) defines IS success as "a measure of the degree to which the

person evaluating the system believes that the stakeholder (in whose interest the evaluation is being made) is better off".

Grover, Jeong and Segars (1996) argue that the construct space of IS effectiveness measures requires definition of the (1) evaluation referent (system A versus system B, comparison to a theoretical ideal, or comparison of one system over time), (2) unit of analysis (individual or organizational), (3) evaluation type (the process of IS use, the user's or organization's response to IS use, and/or the impact of IS use), (4) domain of study and (5) evaluation perspective (e.g. users, top management, IS personnel, and external entities).

In line with Seddon et al. (1998) we too think that the notion of "the" dependent variable or one "comprehensive measurement instrument" of success is too simplistic. What constitutes a success from one perspective could be regarded as a failure in another, e.g. because of different measurements of success. Success is in the eye of the beholder. The evaluation perspective is important - different stakeholders are likely to use different evaluation (success) criteria, and as a consequence very different measures of value are needed for different stakeholders. Consequently we need to determine what constitutes a success from the different perspectives. A healthy starting point is to let the respondents not the researchers define what constitutes a success (Coe, 1998).

3. Stakeholders

A review of the literature focusing on SPI stakeholders reveals that lack of awareness concerning the different perceptions of success can have a negative influence on the project outcome. Sakamoto et al. (1998) analyzing the SPI efforts at the OMRON Corporation concludes that one of the main problems the company had experienced under the implementation was the lack of a shared goal among stakeholders.

In a similar vein O'Hara (2000) reporting on different European experiences with Software Process Improvement, cites a SPI program manager in Allied Irish Bank (AIB) for saying that one of the issues that increased the SPI projects chances of success was the strategy based on identification of all project stakeholders and then assurance of achievement of some benefit as well as their needs.

3.1 Definition

Consensus and by-in from all stakeholders are pointed by Zahran as one of the ingredients for successful SPI (Zahran, 1998). We assume that such consensus can be achieved by understanding and taking into consideration each stakeholder's success criteria.

Thus the stakeholder seems to be an important role to be identified. But what

is a SPI stakeholder? The term 'Stakeholder' according to stakeholder literature can be defined as "[…] any group or individual who can effect or is affected by achievement of the organization's objectives" (Freeman, 1984, p.46). Since we are focusing on Software Process Improvement we need a more specific definition of this term – 'SPI stakeholder'. The CMMI model (Chrissis et al., 2003, p.629) defines the term stakeholder as,

> *A group or individual who is affected by or is in some way accountable for the outcome of an undertaking.*

Yet another definition of SPI stakeholders is given by Zahran (1998). He defines stakeholders as (Zahran, 1998, p. 187),

> *Individuals who have interest in the success of SPI program.*

These two definitions illustrate how different one can view a stakeholder, and the gap between them holds potential for conflicts. Zahran's view seems too simplistic since there are almost certainly also stakeholders who do not have an interest in the success of the SPI program, and if their interests and need are left unidentified they can pose a latent threat to the implementation of the SPI program. The CMMI definition seems more realistic and appropriate taking into account the individuals actually affected by the undertaking.

3.2 Role Perspective

One of the most significant approaches in IS for identification of stakeholders has been suggested by Lyytinen and Hirschheim (1987). They introduced four criteria for the stakeholder identification process. However they have also underlined the complexity of this task. Pouloudi and Whitley (1997) describe the process of identification of IS stakeholders based on the stakeholder analysis and inter-organizational systems literature. They suggested four principles that can characterize the stakeholders' behavior, and can further assist in identification of stakeholders. Those principles assume the contingency of stakeholders' positions, their wishes and who the stakeholders are in time and context as well as stakeholders' inter-relations. It makes the exhaustive mapping of all SPI stakeholders as a very complicated. It will vary from project to project, from organization to organization, the list will be too extensive, and it will take a lot of time and effort attempting to deal with all of them. Such effort in Dansk Data identified 30 SPI stakeholders (Mathiassen et al., 2001). This number forced the project members to find another approach (the role model) instead of the traditional stakeholder analysis to make it more tangible. The role model has been inspired by Checkland & Scholes (1990) and Bendix & Andersen (1995) and reduced the number of subjects for analysis from 30 to 5.

We believe that using the term 'role' in our study (here mapping of SPI stakeholders) could help us to light up the most 'visible' actors on the SPI-scene.

By 'role' is meant a social position recognized as significant by people

> *in the problem situation. […] A role is characterized by expected behaviors in it, or norms. Finally, actual performance in a role will be judged according to local standards, or values." (Checkland and Sholes, 1990, p.49)*

Keeping the role-thought in mind we look at the CMMI model where they suggest to decrease the number of objects for the stakeholder analysis by using the term 'relevant stakeholder' "*in most practice statements to describe the people identified to contribute to a specific task*" (SEI, 2004). The CMMI model suggests identifying the relevant stakeholders:

> *[…] among the suppliers of inputs to, the users of outputs from, and the performers of the activities within the process (Chrissis et al., 2003, p.44).*

Inspired by above definition we suggest three roles (Figure 1) of SPI stakeholders which interest or success perception should be taken into consideration:

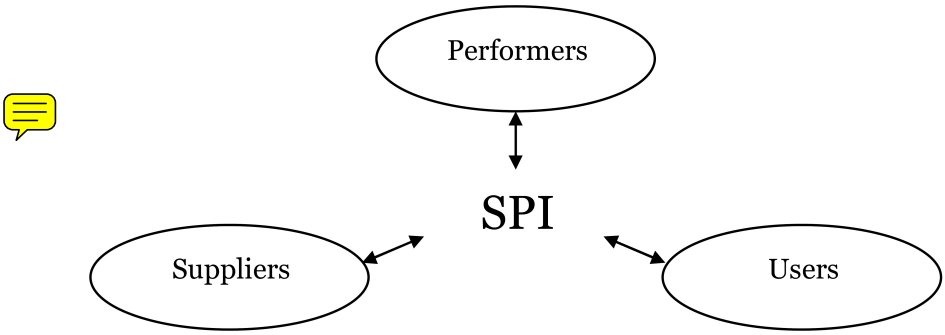

Figure 1. SPI Roles

The *suppliers* are stakeholders actively involved in initiating and sponsoring a SPI project. Their input to the project can for example be characterized by distribution of resources, knowledge and power.

Performers are responsible for development, implementation and drift of processes in the organization under the SPI program.

The *users* are all characterized by not being directly involved in the SPI. They are subject for the results of the SPI project and therefore have to conform to the requirements defined in the processes definitions.

3.3 Organizational levels

We acknowledge that for each of the roles the success criteria will differ depending on the organizational level they operate on. Inspired by Abrahamsson (2002) we suggest three levels of actors: individual (personal),

project (operational) and organizational (strategic).

Thus a new dimension for roles has been introduced:

Role \ Level	Organization	Project	Individual
Supplier	Sponsor	Steering Committee	Advisor
Performer	SPI Unit	SPI PM	Process developer
User	Customer	Development PM	Developer

Table 1. SPI Role Matrix

3.4 Supplier Roles

Suppliers provide the organization with resources to realize SPI related activities.

The Sponsor – typically top management - is placed at the organizational level and consequently has the responsibility for initiating and supporting the SPI activities. The sponsor gives a formal appointed unit mandate to go through with software process improvement in the organization. In addition it is the sponsor's responsibility to set aside monetary as well as human resources. The sponsor - given the organizational level – has the responsibility for aligning the SPI program according to the actual business needs.

The steering committee is the official group formed with the purpose of defining and scoping the SPI program. The unit has the responsibility for initiating an appraisal and hence define the formal goals of the SPI project. It is the responsibility of this role to judge whether the SPI project is compliant with the requirements of the chosen process improvement approach by monitoring the progress. An important task for this role is to authorize other roles to commence and take charge of the SPI project.

At the individual-supplier level the *Advisor* role is located. All who has an incitement for contributing to the SPI project are located here whether they are internal and external to the organization. External individuals comprise consultants where internal individuals may be represented through developers. Common for this group is that all actors who fit into this role act on behalf of her own needs as a supplier to influence the SPI activities in some way. The individual may provide assistance or otherwise state their opinion or simply act as sparring partners.

3.5 Performing Roles

The performing roles are responsible for developing and implementing the quality improvements activities in the organization.

The role as *SPI Unit* can be an independent function that supports the formal goal of the SPI program. This constellation is typically met in mature organizations where dedicated resources for continuous improvements have been allocated. Organizations that are new to SPI, will most likely not have a dedicated SPI unit, but might have a Quality Assurance department or similar organizational body. The prime concern of this body is to coordinate the various SPI initiatives and aligning these with other functions to meet business demands in the best way possible.

The *SPI project manager* is in charge of the SPI initiative. The overall responsible for that the implementation is according to the formal goal rests with this role. The project manager must ensure that all involved stakeholders work together productively (Grady 1997, p. 12) as a team.

The *Process developer* role is occupied by the employees that work in the SPI project. Their job is to document and define new processes and ensure a consistent implementation throughout the organization. On the basis of the input by the supplying roles and coordination of the SPI project manager they must initiate the correct actions for achieving the formal goal of the project.

3.6 Users

The user level describes the users of the results produced by the performers. This will be the actual processes defined as a result of the SPI work. The users are internal to the organization and attend the daily software developing activities.

The *Customer* role covers the independent units that comprise the organisation. Provided that the organization is characterized as a divisionalized software company it would be a fit illustration. Divisions are often managed independent of each other and hence follow different strategies in order to fulfil diverse business objectives.

Development Project Managers for product oriented tasks play a key role in SPI. A successful implementation relies on an engaged project manager since responsibility for the daily enforcement of SPI activities are performed by this role. In addition he is responsible for encouraging the rest of the project team to be compliant to the defined processes.

The last role at the user level is the *Developer* or corresponding person who works in a project not directly involved in SPI. They are the users of the product developed by the performing stakeholders.

4. Method

4.1 Literature study

Based on the literature we studied the term 'SPI stakeholder' and process of stakeholders' identification. Recognising the intangibility of this task we have developed the SPI Role matrix, mapping 9 stakeholder roles depending their organizational level and role in SPI. The matrix was aimed to be used only as a structuring instrument for analysis of success criteria.

4.2 Data collection and analysis

The data which is the foundation for the present paper was collected in a study focusing on critical success factors in SPI initiatives. The aim of this study was to uncover the critical success factors from the respondents' viewpoint based on a concrete recently developed and implemented SPI project they had all been involved in. The data was collected before we developed the SPI stakeholder matrix, and thus not all roles are covered. In order to generate data to support the research question we decided to rely on qualitative data to let the respondents own reflections guide our findings and not our preconception express in e.g. a survey questionnaire. A semi structured interview guide was employed to create a coherent sampling frame thus obtaining cross-case comparability yet without ruling out the possibility of encountering new interesting topics during the interviews. The data collection was conducted in a continuous iterative interplay between data collection, data reduction, data display and preliminary conclusion drawing (Miles & Huberman, 1994, 12), allowing us to readjust our data collection instrument during the data collection phase.

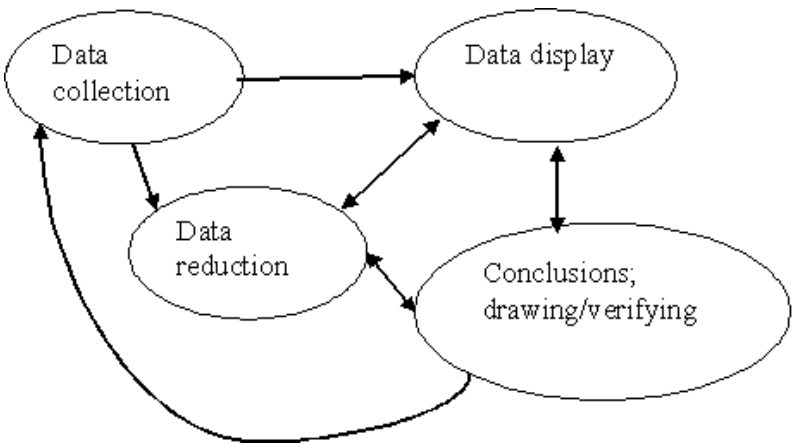

Figure 2. Components of data Analysis: Interactive Model

The interview guide was exhaustedly open containing only 6 questions one of them focusing on success in relation to the SPI project they were involved in.

The interviews were conducted by 2 person teams, one asking questions following the sequence of the interview guide, the other writing notes and reflecting and asking elaborate questions assuring we had the essential themes covered. The interviews were conducted during the fall of 2003, each interview lasting approximately 1 hour and were tape recorded with the respondents' knowledge and permission.

Initially each interview was transcribed leaving out only slips of the tongue and hems and then analysed individually and coded according to the terms used by the respondents using Atlas.ti.

The overall idea is to become intimately familiar with each case as a stand-alone entity. This process allows the unique patterns of each case to emerge before investigators push to generalize patterns across cases. Eisenhardt, K.M. (1989:540)

Then we proceeded to do cross-case analysis by comparing the codes and looking for common themes and constructs and implicit and explicit relations among the tentative codes.

4.3 Companies in the Study

The cases were selected asking three Danish software houses to choose one or two successful SPI projects. In order to get a comprehensive and holistic understanding of each case we interviewed several profiles involved in the actual SPI project under investigation; see Table 2 for an overview of companies and respondent profiles. The participating companies all requested to be anonymous why they have been named Alfa, Bravo and Charlie.

Name	Industry	SPI Projects	Respondents Position	Role
Alfa	Investment and treasury management systems	Test Progress	Head of Test Department	Customer
			Software process developer	Process developer
			Software Engineer	Advisor
			SPI Project Manager	SPI Project Manager
		Measurements	Head of Department	Sponsor
			Software Engineer	Developer
			SPI Project Manager	SPI Project Manager
Bravo	Electronic payment services		Head of Department	Customer
			Software Engineer	Developer
			SPI Project Manager	SPI Project Manager
			Methods developer	Process Developer
Charlie	Pension and social security solutions	Project management model	Head of IT Department	Sponsor
			SPI Project Manager	SPI Project Manager
			Software Engineer	Advisor
			Methods Developer	Process Developer

Table 2. Overview of Respondents and Affiliation

5. Findings

In the following section we will present the interesting findings in relation to our research question. Introducing each section we will sketch out in bullet form what the respondents name as constituting a success from their point of view. Due to the qualitative approach to our study these bullets are not prioritized by the respondents but have come up at various points during the interviews. Following this we will analyse the data more in depth presenting actual quotations from the interviews to back our analysis.

5.1 Sponsor

Two of the respondents are categorized as *Sponsors* in their respective companies. The high organizational level of their position explains their expectations to the result of the SPI project. Their criteria for success are as follows:

- Institutionalization of the SPI product
- Effectiveness of projects (time to market)
- Better collaboration with business unit

- Homogeneous processes
- The overall goal of the SPI project is achieved

The analysis indicates that the S*ponsor* mainly is concerned about the successful implementation of SPI in the sense that it proves useful to the organization and it is in fact used.

> *"We expect it [the SPI product] can be used and is used in the different business areas of our organization [Charlie]."*

Furthermore there is a focus towards benefits gained from the SPI initiative. It is a general tendency that the *Sponsor* regards success as increasing the effectiveness in comparison to the existing software development process. The effectiveness is gained through an alignment of the processes and a standardized way of doing things. Success is defined as a fulfilment of the formal goal of the SPI program.

5.2 Customer

The interviewed respondents in this category have a position as a manager of the organizational unit (department/division) that are faced with the implementation of the result of the SPI project. Their criteria of success are:

- Usability of the SPI Product
- Functionality of the SPI Product
- Improved development processes
- Homogeneous quality of SW product
- Improved process and SPI tool support work processes

The C*ustomer* in the form of the organizational departments has a more practical view on success. It is decisive that the SPI is easy to use and results in better performance.

> *"[Success in this case is] we become better at test [the SPI initiative] and that we perform homogeneous (Charlie)"*

> *"Success is that it is easy too use (Alfa)"*

In the case that the changes result in problematic work practises that is not adopted by the employees in the department, it will be regarded as a failure. It is paramount that the employees affected by the changes accept the new work processes and practices and preferable by own interest in the sense that they experience the SPI initiative as a relief in their everyday work.

> *"[Success in this case is] that our projects will experience support from the process and the tool (Bravo)"*

Another general trend is that the C*ustomer* has a more client oriented approach to SPI. Success is consequently attained if the *Customer* experience a consistent way in the performance of work related activities as well in the results. Through reliable processes and supporting tools a success criteria is an increase in the quality of the products as well in the process for instance in the form of meeting deadlines.

> "The customer is too experience increased quality in the product we deliver (Bravo)"

5.3 Advisor

Respondents on this level have been actively involved in the development process as suppliers of for example knowledge, experience and articulated needs. Their success criteria are:

- Learning
- Recognition of the underlying principals of SPI
- Personal Awareness
- Applicability
- Proper Implementation of SPI
- Accountability of SPI

The motivating factors for this role can be diverse. But two tendencies are supported by the data. The first tendency has a very subjective as well as a political impact on the grasp of success criteria. Employees who participate in the SPI tasks, but who is not a dedicated member of the SPI team, often have personal issues to tend. It must be stressed that this not necessarily is a bad thing. It can be interpreted as a way of getting influence on the design of the processes, practices or tools in such a way that the employee ensures personal acceptance or as a dedicated commitment to the SPI work to secure an appropriate implementation in the organization.

The second tendency is more personal. It is about personal recognition of the SPI paradigm. By being personally involved in the process the employees become conscious about the activities initiated by the SPI program. In this way they gain personal insight and learn what effect SPI has on the organization. Success for this group of stakeholders can thus be regarded as being dependant on the degree of influence on the project or the level of conception gained as a result of active involvement.

5.4 SPI Project Manager

The respondents on this level have a position as SPI project managers. The identified success criteria are as follow:

- The project result acceptance
- Goal achievement according to plans
- Innovation
- Extension of use
- Acknowledgment from others
- Implementation at the right time and in the right place

In the interviews the *SPI project managers* emphasise that it is important that the organization accepts the new processes. It is abundantly clear that the SPI project Manager must oblige many stakeholders' expectations. They must perform within the charted course set by management at the organizational level and at the same time deal with the implementation at the individual level, for example the personal acceptance by the employees of a new way of doing things.

> *"Success is constituted at several levels. To the company it is economy while at the organizational level it is whether or not the process is being used in the right places. At the individual level success is whether or not the process is a relief in and supports daily work. (Bravo)"*

Though many SPI projects are subject to the classical success parameters equally as product oriented projects such as time, resources and quality and the interviewed SPI project managers do express concern to realize the planed SPI activities within the allocated resources, it is not these parameters that constitute personal success to them. All accentuate the importance of the usefulness of the developed and defined processes. If the processes are accepted by the employees and it is obvious that these ease the daily work routines it can be perceived as a success.

> *"Success in a project like this is that it is actually being used […] and that the users are happy using it (Alfa)"*

This concern is also to legitimize to users and top management that SPI is in fact a healthy investment.

5.5 Process Developer

The process developers have a central role in developing and implementing SPI in the organization. They are responsible for defining and document processes that are compliant with the chosen SPI framework as well as tailoring these to the people and organizational structures present. The identified Success Criteria are as follow:

- Extension of use
- Customer satisfaction

- Deadlines are kept
- Good product

The process developers have a central role in developing and implementing SPI in the organization. They are responsible for defining and document processes that are compliant with the chosen SPI framework as well as tailoring these to the people and organizational structures present. Success for this role is of personal matter. People who engage as process developers find it satisfying to contribute to the organization and have influence on the structural design of the organization.

> *"Success to me personally is when I develop something that provides benefit [to the individual and organization] (Bravo)"*

But they are also driven by the anticipation of that the organization benefit positively from their contribution. Besides from the influential part the data reveals that process developers regard their effort as a success if it enhances the organizational effectiveness. The final acceptance - and the tangible token of success - occurs during the communication and transfer of knowledge to employees if they accept the improvements frankly.

5.6 Developer

Employees who fit into this group of stakeholders regard SPI as a success if following criteria are fulfilled:

- Extension of use
- The SPI product supports their work

It is noticeable what *Developers* request of SPI: SPI must support the daily work activities. If this requirement is not met, then they will find alternative ways of bypassing the defined processes.

> *"SPI is a success if the process helps and is used (Alfa)"*

However it is stressed in the interviews that they regard it as a success if all developers accept and follow the defined processes.

6. Discussion

In this section we will discuss relevant topics based on the findings and answer the questions raised in the beginning: What constitutes a success? The analysis does not give a clear answer to this question, but it does however point out that the identified roles have different criteria for attaining success.

Both theory and empirical study indicate that there is an ambiguous definition of success within the field of SPI. We argue that it is most important not to

define success but explore what constitutes it. Success as a dependent variable has been evaluated in our study by different stakeholders with the different levels of organizational responsibilities and roles in SPI. They perceived the SPI projects as success but an exploration of their success criteria shows different viewpoints for how success is obtained. Most of the respondents have been aware of the projects' goals and objectives, but the actual achievement of the goals has been mentioned as success criteria only by the sponsor role and SPI project managers. Thus there is no equality between a goal and a success.

6.1 Goal, Success and Success Criteria

Before we discuss the findings in details the definition and mutual dependency of three terms must be clarified: Goal, Success and Success Criteria.

Merriam-Webster defines the term goal as *"the end toward which effort or ambition is directed"*. To be able to evaluate whether the goal is realised it must be clearly defined. Only when the goal is stated is it possible to determine if an effort can be regarded as a success or not. Following the definition of success, success can be seen as the degree of attaining the desired goal. This means that the number of fulfilled success criteria determine the degree to which a stakeholder perceives an effort to be a success or not.

In the above analysis we have used the term *formal goals*. This term must not be confused with the individual stakeholders' personal goals. The above description of the mutual dependencies of the three terms take for granted that the individual defines his own goal. By introducing the term *formal goal*, we open up for the possibility that many individual goals are in play at the same time.

Even though an SPI project has defined formal goals, it can not be taken for granted that they are supported by all stakeholders. But even though stakeholders might not share a common goal it is possible to achieve success to a certain extend. Following the above clarification it is the success criteria that define whether a stakeholder regards an effort as a success or not. If the success criteria can be obliged it may satisfy multiple personal goal-settings.

The actual behavior of SPI roles is to a high degree determined by the experienced contribution/reward balance than by the overall formal goal of the project (Mikkelsen & Riis 1998). The success of an SPI project can therefore be said to be constituted by the actual fulfillment of involved persons' success criteria without regard to the goal of which it belongs. It is obvious that it is hard, if not impossible, to comply with all demands. But since success is defined as a degree of attaining a goal, it is reasonable to say that success is obtained if the success criteria of the persons participating rise above an implicit declared threshold, given that high priority success criteria is met among all roles.

6.2 Roles vs. stakeholders

In the analysis we have used a new frame of reference for identifying stakeholders in relation to SPI. The SPI Role Matrix has so far proven itself as an advantageous method to categorise stakeholders. By taking a role view on SPI stakeholders, we have defined responsibilities and provided a clear understanding of the involved stakeholders' contribution, level of involvement, interface and the degree of influence or control each stakeholder has on the degree of success for SPI (Chrissis p. 239).

The analysis shows that success criteria identified for persons belonging to a specific role share some characteristics. This justifies the aggregation of stakeholders. The stakeholders belonging to a specific role regard the SPI initiative from the same perspective and for that reason share success criteria. The role view does however have some implication for the analysis.

When we look upon stakeholders as groups with distinct functions in relation to SPI we actually make a high level aggregation. This implies that we are looking for common success factors shared by a group of people and hence objectives the success factors. This analysis leaves no room for personal success factors. Persons with a hidden agenda or political purposes for engaging in SPI activities are not identified. Likewise it is not possible to identify implicit success factors.

By developing a SPI Role Matrix that is based on an organizational perspective that distinguishes among three different levels of the organization, we implicit preclude the influence of the external environment. However, any SPI activity should be triggered and driven by external factors, for example maturity and quality requirements requested by the market, or customers' demands. For that reason a basic assumption of the SPI Matrix is that external interests and thus success criteria are safeguarded by the identified internal roles. The empirical findings apparently support this assumption. In all cases the Sponsor role attended to the external requirements of the business; but it must be emphasized that the SPI Role Matrix does not guarantee this.

Because external interests and success criteria is mapped onto internal roles in the organization, we have chosen to exclude external stakeholders in our attempt to defined success criteria relevant for SPI. This we justify by claiming that SPI is an in-house activity, though it must be driven by demands external to the organizations. It is the responsibility of the Top Management/Sponsor to consider if it is feasible to initiate SPI on the basis of the market settings in which the business operate. We are convinced that the SPI Role Matrix covers all relevant stakeholders' interests.

7. Contribution

The research contributes to the SPI field in two ways. First of all it helps SPI project managers to be aware of the differences in stakeholders' perception

of success. Stakeholders' success criteria are important for obtaining formal goals of SPI initiatives but are often neglected. Secondly the SPI Role Matrix provides a framework for viewing SPI in organizations. It displays how success criteria differ depending on the role and organisational level of stakeholders in SPI.

8. Future Research

The SPI role matrix was used to analyze the interview. Six out of nine roles categories were covered by the empirical data. It was not possible to cover the entire matrix because of the organizational structures of the participating companies. Those roles that did prove relevant for the study of success factors have in our opinion contributed to a better understanding of how SPI can be perceived in organization in relation to organizational actors. It is our intention to complement the empirical work by making interviews in other organizations to prove that the remaining categories can be relevant.

9. Conclusion

In this article we have attempted to stress the importance of identifying stakeholders' success criteria. The article is not a normative attempt to identify definite applicable success criteria across organizations for neither stakeholder nor roles. On the contrary the article demonstrates - supported by empirical examples – that stakeholders have different conceptions of what constitutes a success.

Table 3 provides a summary of the domain of success criteria for the identified roles.

Roles	Domain of success criteria
Sponsor	Organizational adoption Alignment with business needs
Customer	Usability Functionality
Advisor	Influence Personal learning process
SPI project manager	Stakeholder acceptance Achievement of formal goals
Process developer	Provides benefits to both individual and organization
Developer	Support of work

Table 3. Respondents' domain of success criteria

The context in which organizations are situated will always differ; for that reason the individual organization will always be responsible for identifying relevant stakeholders and their individual Success Criteria. If this is done thoroughly the chances for success for SPI is increased. To help project managers identify stakeholders, we have suggested a role-view. Many stakeholders hold the same role and consequently share objective success criteria. Nine stakeholder roles are identified for SPI initiatives. The empirical findings support the SPI Role Matrix; however further empirical studies are needed to prove the validity of the Matrix.

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A Qualitative Interview Study Investigating the Role of Transport Information Systems in Road Haulage Firms

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Abstract: *Recent advances in mobile and wireless technology have made possible new types of information systems supporting key activities in transport organizations. By including mobile actors and equipment, such technology is a key enabler for realizing the vision of enterprise system support in this context. This paper focuses on a particular type of transport organization, that of road haulage firms. The term Transport Information Systems (TIS) is used to discuss a specific type of enterprise technology, incorporating support for critical mobile aspects of road haulage firms and relevant functionality of conventional enterprise systems. To capture expectations of enterprise support in road haulage business, a qualitative interview study including 18 Swedish road haulage firms was performed. Building on the results of the study, this paper contributes a set of sociotechnical challenges important for successful implementation of TIS in road haulage firms. In addition, this paper outlines implications for future research on enterprise systems in transport organizations.*

Keywords: Transport *Information Systems, sociotechnical issues, road haulage, technology use*

1. Introduction

Rapid developments in mobile and wireless technology have made possible new types of information systems supporting fundamental activities in transport organizations. While this is a novel development, organizations facing intense

competition have historically viewed information technology (IT) as a means to improve internal performance. For decades, information systems have been developed to increase productivity in a wide variety of business functions. This has resulted in a plethora of in-house developed systems, dealing with specific subsets of the entirety of an organization's business activities. Whereas such systems may alleviate the problems that they were designed to address, a consequence is a fragmentation of the information system support when applying a strategic view of the entire organization (Markus & Tanis, 2000; McKenny & McFarlan, 1982). This state of affairs created a market opportunity for a new type of enterprise systems that has become known as enterprise resource planning (ERP) systems. The main purpose of these systems is to remedy the information fragmentation of the function oriented legacy systems (Davenport, 1998). This is typically achieved by incorporating functionality, similar to that of previous legacy systems, as modules in an enterprise system intended to support all business activities in one bold leap. Marcus and Tanis (2000, p.173) define enterprise systems as "…software packages claiming to provide a total, integrated solution to companies' information-processing needs". Typically, enterprise systems facilitate integration through efficient and seamless communication between people as well as the systems they use in an organization (Davenport, 1998). Whether or not enterprise systems deliver as promised is still a subject of intense debate, and there is a multitude of research papers describing technical as well as social aspects of such systems in a wide range of business areas. Examples of earlier studies include organizations within manufacturing (Murphy & Simon, 2002), finance (Skok & Legge, 2001), health care (Soh et al., 2000), and academia (Scott & Wagner, 2003). However, a review of the IS literature illuminates the absence of studies of the implementation and use of enterprise systems in transport organizations.

In this paper, we direct our attention to a particular type of transport organization, that of road haulage firms. The typical road haulage firm coordinates a workforce mainly consisting of drivers who are geographically distributed and constantly moving, providing timely pickup and delivery of goods. Recent advances in mobile and wireless technology have enabled the development of a wide range of sophisticated applications supporting these daily activities. Tactical IT tools support positioning of trucks and cargo, recording of performance parameters from the vehicle, and wireless communication of data from some or all of these tools. The positions of individual trucks can be presented on maps, offering the dispatcher a quick overview of the geographic distribution of the resources. Route calculation done by the driver in the field or by the dispatcher is intended to minimize the cost of an assignment in terms of time and fuel expenditure. Road haulage firms are starting to implement these support tools, indicating that these organizations have needs in excess of those addressed by conventional enterprise systems. We use the term Transport Information Systems (TIS) to discuss a specific type of enterprise technology, incorporating these mobile aspects as well as the relevant functionalities of traditional enterprise systems.

In view of recent calls for IS research efforts targeted at use of mobile and wireless technology in organizations (see Jessup & Robey; 2002, Lyytinen & Yoo, 2002), there is a need for studies investigating available commercial packages tailored to meet the requirements of highly mobile transport organizations. To understand the role of enterprise systems in such organizations, we must explore their needs and experiences of technology. IS researchers have suggested several different theoretical frameworks for studying implementation and use of IT in organizations. In this research, we draw on Orlikowski and Gash's (1994) technological frames approach. Building on results from a qualitative interview study designed to capture expectations of enterprise support in Swedish road haulage firms, this paper contributes a set of sociotechnical challenges critical for successful implementation of TIS in this type of organization. In addition, the paper outlines implications for future research on enterprise systems in transport organizations.

This paper proceeds as follows. First, we describe our specific application of the technological frames approach. This is followed by a presentation of the research context and our method applied. We then present expectations of enterprise support in road haulage firms from our qualitative interview study. Discussing our research results, we elaborate on a set of sociotechnical challenges critical for successful implementation of TIS in road haulage firms. To conclude, we draw out the implications of our results for future IS research on enterprise system support for transport organizations.

2. Technological frames

Much research has focused on how individuals make sense of and assign meaning to their environment, organization, and task. Most researchers suggest individuals to have mental models that they use to interpret and understand their surroundings. These models are also recognized to form the basis for producing action (Weick, 1979; Kiesler & Sproull, 1982; Porac et al. 1989). While stressing that mental models or interpretive schemes constitute an important foundation for humans' individual interpretations and action, many researchers argue that members of a particular community have a set of core beliefs in common (see e.g., Porac et al). Being shared by different individuals, these commonly held frames of reference can be seen as results of socialization processes (Berger & Luckman, 1966).

Gioia (1986, p. 50) defines frames of reference as "definitions of the organizational reality that facilitate perception, understanding and action". Individuals' frames of reference include assumptions, knowledge, and expectations, communicated symbolically through language, visual images, metaphors, and stories. Typically operating in the background, frames of reference have both facilitating and constraining effects. Whereas frames of reference can be described as helpful in that they, for example, structure organizational experience, allow interpretations of ambiguous situations, and provide a basis for action, frames can also inhibit creative problem solving

and reinforce unreflective reliance on existing assumptions and knowledge (Gioia, 1986).

According to Orlikowski and Gash (1994), a subpart of people's frames of reference is about technology. Coining the notion of technological frames, Orlikowski and Gash theorize how users apply assumptions, expectations, and knowledge to understand and make sense of technology in organizations. Examining taken-for-granted conceptions of technology in organizations, they assert, can provide an understanding of the role and consequences of technology in a specific situation, place, time or project. In other words, such an understanding includes both the technology as such and its role but also specific states of affairs that consequences of technology have in a particular context. Orlikowski and Gash argue that social groups in organizations will develop or carry different technological frames because of their roles and relations with technology. For example, managers tend to have a strategic understanding of technology, expecting it to support new ways of doing business and hence generate profit. On their part, users typically focus on how technology can be deployed to facilitate everyday tasks. An assessment of the technological frames of particular actor groups can thus facilitate the prediction of potential difficulties and conflicts associated with a specific introduction of an information system in an organizational context.

In view of our ambition to understand needs and experiences of TIS as perceived by road haulage firms, the technological frames approach is an appealing option. However, rather than cross-examining statements within a set of different typical actors, we have chosen to concentrate our efforts on knowledgeable individuals in several road haulage firms. The rationale behind this approach is our aim to explore expectations of TIS in the Swedish road haulage business sector through the lens of influential individuals likely to have a decisive impact on the implementation and use of IT in their organizations.

What we set out to capture is these individuals' general notion of the role of TIS in the everyday practice of road haulage firms.

3. Research context and method

3.1 The anatomy of Swedish road haulage firms

Road haulage firms typically transport some kind of goods from one place to another, using trucks. At first glance, these organizations appear to be similar, dealing with the same slice of reality often in similar ways. The most obvious example suggesting such similarity would be that trucks, drivers, and transport activities constitute the core of the organization. However, the road haulage business sector is far from homogeneous in that core business activities, organizational structures, and size vary. Road haulage can be characterized

as a diversified line of business, covering both local distribution of goods requiring loading and unloading several times each day, and long distance transports where it can take days between loading and unloading. Accordingly, the nature of work differs, ranging from rather static work where transport activities can be planned ahead to dynamic situations in which assignments have to be communicated to the driver during the day. Regardless of the actual setup in different organizations, there are a number of roles typically found in a road haulage firm. These roles are dispatcher, driver, management, administrative personnel, and vehicle maintenance personnel. Dispatchers handle the incoming assignments and organize drivers and trucks, being the resources involved in transporting goods. Drivers transport goods, which involves loading, unloading, the actual driving and planning of routes, as well as interacting with clients. Managers are responsible for economic planning and follow-up. Administrative personnel handle tasks such as wages and invoicing. Finally, there are personnel involved in activities such as vehicle maintenance, supervising of fleet status, service time scheduling, and the changing of tires. The borders of these task related roles are fluent. Depending on business size, the same person can have more than one role, or several persons can have a similar role. The larger the organization, the more specialized personnel you are likely to find.

The Swedish Road Haulage Association states that in the late 1990's, almost 90% of their members operated approximately five vehicles, indicating that most Swedish road haulers are small firms. In the current situation, the Swedish transport industry undergoes changes occasioned by European Union's "open market". For example, foreign transport firms have increased their share of transportations considerably, which is a direct result of the fact that the cost level is lower in nearby countries (15-20% lower in countries such as Denmark, Germany, and the Netherlands, and 30-40% lower in countries such as Poland). This cost disadvantage has resulted in minimal profitability margins for small and independent road haulage firms. In this context, contractors of haulers like Danzas and Schenker have strengthened their market positions. To improve their competitiveness, road haulage firms are starting to implement different types of IT support. Analogous to IT investments in other types of organizations, the size of road haulage firms is an important factor in that it determines the available amount of resources for procuring and administrating IT support. As a practical implication, Swedish road haulage firms rarely afford to develop a custom-built system, forcing them to consider the various "off-the-shelf solutions" available. Though, in many situations the wide variety of business activities in road haulage firms makes this choice complicated and sometimes even impossible. However, it seems that road haulers try their best to overcome such struggles associated with implementing advanced technology, indicating a desire to explore the potential benefits that adequate IT support could bring.

3.2 Research project on Transport Information Systems

This study is part of an action research project named "Value-Creating IT for Road Haulage Firms". Intended to generate general guidelines for how TIS should be developed and implemented based on the needs of road haulers, the project is conducted as a collaborative effort where researchers from the Viktoria Institute, systems vendors (Hogia, NL Partner, and Vehco), and truck manufacturers (Scania and Volvo Trucks) develop, implement, and evaluate TIS together with road haulage firms. Of the different stages included in the action research cycle as defined by Susman and Evered (1978), the study presented here is part of the early diagnosing phase. While the overall research project is directed towards IT support for road haulage firms, this study is the first activity in which we investigate the concept of TIS as seen through the eyes of influential individuals in this particular line of transport business. The results from this initial work are to serve as first input into future research activities where our findings form the basis for further studies in situated organizational contexts within which specific action will be planned and executed.

Collection of the main empirical data was conducted through a series of 18 interviews with key personnel in various road haulage firms in the autumn of 2002. The Swedish Road Haulage Association, representing approximately 11000 contractors with some 30000 vehicles and machines, recommended a number of potentially interesting member road haulage firms. The choice was based on their level of experience acquired through advanced usage of specialized IT support in day-to-day practice. These organizations were diverse in terms of core business, structure, and size. This diversity was beneficial in view of our attempt to understand the situation experienced by road haulage firms in general. Examining potential similarities and differences between organizations, we chose to interview influential individuals in leading managerial positions. Due to the limited size and complexity of small and medium sized firms, managers are usually involved in every organizational process and tend to have a comprehensive perspective of all organizational issues (Calderia & Ward, 2002). Besides the managerial perspective of the interviewees, most of these individuals also had previous personal experience of the truck driver or the dispatcher roles, thus providing an interesting source of information on these roles as well.

Intricate organizational interdependencies with substantial situational variations can be hard to identify using formal methods for collecting data (Walsham, 1995). We cannot fully know the questions that generate the desired understanding in advance. Therefore, in order to acquire a rich picture of the actions and processes in the organizations, the primary method for our data collection was semi-structured interviews, lasting between one and two hours. This technique has the potential to illuminate potential particularities of the individual organizational settings in question, by allowing forming and reforming of alternative questions as well as detailed explanations and

interesting detours whenever necessary (Walsham, 1995). However, some structure is retained so that there is satisfactory correlation between the different interviews. The interviews were recorded and later transcribed, resulting in a body consisting of some 350 pages of empirical material. During the analysis, the data was first examined in order to find statements reflecting the respondents' expectations, assumptions and knowledge of technology and its implications for work and their organization's processes. After this, we approached the data in an open-minded manner, meaning that the data itself suggested concepts and categories. The concepts and categories were revised and refined until they sufficiently explained as much as possible of the data. Our empirical findings can thus be said to have emerged from an iterative and interpretive analysis of the collected data (Walsham, 1995).

Besides our empirical efforts to capture expectations of TIS in the context of road haulage business, we have also conducted an IS literature review in search for research contributions addressing the implementation and use of enterprise systems in transport organizations. This review included top IS conferences and journals and covered the period between 1990 and 2004. While our review indicated the absence of research efforts focusing on this topic, the general literature on enterprise systems has served as useful input in our quest to understand sociotechnical challenges associated with expectations of TIS in road haulage firms.

4. Results

On the basis of our qualitative interview study covering influential individuals in managerial positions, assumed to have a decisive impact on the implementation and use of IT in their organizations, this section presents their understanding and expectations of TIS in the context of road haulage firms. Structured as four themes, the assumptions, knowledge, and expectations presented are suggested to capture typical aspects of the role of TIS in this particular type of transport organization. Although these aspects can be seen as illustrative dimensions of the general nature of technology use in road haulage firms, they are not claimed to be exhaustive nor mutually exclusive. Additional empirical investigations of road haulage firms and their general understanding of TIS are likely to add or modify the aspects captured.

4.1 Rationalize internal communication

A fundamental aspect in road haulage is the communication involved in the execution of transport assignments. Information about assignments needs to be transmitted from transport buyers to dispatchers, between dispatchers and drivers, and from drivers to goods receivers. In many road haulage firms, this interaction is mainly handled by phone. However, several of our respondents argued that heavy telephone usage is both stressful and time

consuming. Describing the current situation at the dispatch office at his firm, one interviewee pointed out the potential increase in efficiency by reducing dispatchers' verbal communication with drivers:

> *"There are many incoming calls to the office, which is problematic. Not only do the drivers call but also customers and contractors of haulers and what have you. It can be quite overheated there. So the idea is, although it sounds strange, that we try to talk to the drivers as little as possible, just so that the situation becomes both effective and manageable."*

Technology was perceived to have the ability to address this communication overload in two ways. First, technology was assumed to have the potential to reduce verbal communication through the transmission of formalized messages. One problem associated with verbal (i.e., telephone-based) communication is dispatchers' time spent failing to reach drivers already engaged on the phone or working outside the truck. By sending text messages, dispatchers do not have to rely on synchronous verbal communication. Also, written data was perceived to be more exact than spoken messages, thus reducing misunderstandings. As illustrated by one of the interviewees, facilitating this type of communication between dispatchers and drivers is a main concern for most road haulage firms:

> *"[It is important] to get the orders out and communicate with the drivers in an easier, smoother way so that the communication involved in dispatching becomes easier. They [the dispatchers] are spending two hours a day talking to the drivers using mobile phones - get rid of that. Dispatchers are really stressed these days and we need to reduce their workload. That's what it's about, to send the orders easily and smoothly to the drivers."*

Second, technology was attributed the possibility to entirely eliminate the need for verbal communication in certain types of information gathering. Before communicating new transport orders to drivers, dispatchers need to gather information that is vital for the allocation of assignments (e.g. the location of individual trucks and drivers). In contrast to the transmission of formalized messages, which still demands interaction between two people, positioning technology facilitates automated transfer of information from vehicle to dispatcher, thereby increasing efficiency on behalf of both dispatcher and driver.

However, the respondents also saw limitations to the possibilities of new technology. Although system support for data transfer between office and truck was believed to reduce phone communication between driver and dispatcher, some respondents argued that such technology would not make verbal communication redundant. First, the respondents assumed that some forms of communication do not fit into the format of formalized messages (i.e., discussions and complex questions). Second, road haulage firms have communication needs crossing the boundaries of their own organizations.

While transport buyers transmit information to dispatchers, drivers contact the client at the delivery site before arrival. According to the respondents, external communication partners can not be supposed to share a system for electronic data transmission. In spite of advantages of system support for mobile data communication, respondents asserted that drivers will always need phones for certain forms of communication:

> *"The clients demand that he [the driver] can call when under way. I would say that they call three or four clients out of ten. Regardless of what kind of mobile communication system we get, they can never manage without the mobile phone."*

To summarize, managers appreciated technology as a means to improve efficiency by reducing dispatchers need for verbal communication.

4.2 Facilitate seamless processes

Technology as facilitator of seamless processes by automation of presently manual tasks was a frequent topic of interest among respondents. One primary concern among our respondents was the amount of time elapsed from completion of an assignment to invoicing. Without assistance of wireless communication, invoicing was generally not possible until the driver returned to the office with bills of laden. Depending on the character of the assignment, this could take days. Interviewees frequently mentioned the detrimental effects of delays of any kind in this process on the cash flow of the firm. In addition, manual handling of such documents was demanding in terms of personnel. Indeed, road haulers had noticed that such documents go missing at times. Consequently, expectations of the gains of technology were high in this area, and one respondent regarded this being the main reason to invest in IT:

> *"Why do we need this type of system? So that we can send the bills earlier, that's why. That's the only reason, otherwise we can use pen and paper. We want to send the bill as soon as the transport is carried out, that's were we can make money. The rest of the system is not very important just as long as it makes us able to bill five to ten days faster. If we can shorten the invoicing time five to ten days, the investment in a system would not be a great burden."*

Drawing on experiences from use of technology, one respondent acknowledged the benefits of automating input into an existing maintenance log containing all aspects of information about individual trucks. This would eliminate the presently manual process of compiling such information:

> *"We have a really good maintenance program now. You put in anything you want and you get service orders, when the vehicle is up for service and testing and so on. And you also get a lot of historical accounts of costs, like if some vehicle is expensive regarding tires or fuel or something. That's really good actually. The next step might be to connect*

it directly to the vehicle, as Volvo and Scania are doing, so that you don't have to feed all this data into it. That's excellent."

In this case, knowledge of the possibility to automatically record and receive vehicle data raised the expectation of further improvements by reducing manual handling. However, few saw any immediate feasibility of such improvements. This was attributed to the fact that most road haulage firms had a mixed fleet of trucks. Discouraged by incompatibility issues between different systems for different truck brands, most of the interviewees did not intend to invest in such technology. Incompatibility and lack of integration were seen as major obstacles in efforts to automate information transfer. In the following quote, one manager expresses his frustration over the fact that the internet based order handling system and the cargo planning system were not integrated, forcing dispatchers to manually transfer the data:

"We cannot, sort of connect [the system] by pushing one button, export [data] from the transport order system to the cargo planning system, this must also be possible to do. So far we can only read the orders, print them and then we enter the orders into our cargo planning system manually."

In summary, although technology was attributed the ability to automate tasks and facilitate seamless processes, the problems of systems integration were seen as prohibitive.

4.3 Improve resource control

Constituted mainly of a mobile and distributed workforce, road haulage firms are aware of the benefits of wireless technology support for resource control. There were several interviewees who appreciated technology as a means to enforce company routines and/or policies. A telling example is the reports created by drivers stating their working hours. These reports are then used as input to calculate wages. Most road haulage firms included in the study used dedicated IT support for the actual wages calculation. However, a recurring topic among the respondents was the difficulty to check if the reported work hours were correct. This was an area where potential problems associated with the privacy of the drivers seemed important. While such aspects were acknowledged, the benefits were assumed to outweigh the potential political problems that might arise. The following account depicts one respondent's experience of a system capable of monitoring vehicle and driver activities:

"The main reason why we invested in on-board computers was the reporting of working hours. […] Most drivers are really good at reporting, but you know, fifteen minutes here and there. Fifteen minutes a day per employee and year amounts to quite large sums. We've had drivers reporting both seven and eight hours extra per week. […] We can se when they have started [working] and we think that it's good because it's fair on the drivers. I think that those who have nothing to hide have nothing to fear."

Interestingly, managers claimed that this aspect of control was also beneficial to drivers in that such systems offered them an opportunity to check detailed records for errors:

> *"This only makes it easier for them [the drivers]. They don't need to worry about anything else than pushing these buttons. Then they get a list that they check before the salary is paid. If there's a discrepancy, they can point that out."*

Considering the ever-increasing fuel prices, many of the interviewees pointed out the benefits of using technology support for minimizing fuel consumption. In relation to this, respondents highlighted the importance of educating the drivers accordingly. Although courses on heavy echo driving seemed appreciated, the respondents pointed to difficulties in maintaining the benefits from such education. In particular, the interviewees mentioned two challenges. First, sustaining an improved driving behaviour was viewed as difficult, as drivers reverted to old habits. Second, there was an experienced trade off between carrying out assignments as quickly as possible and driving as economically as possible. Several system vendors offer applications intended to provide the driver with instant feedback on driving performance, thus constantly enforcing company policies. Presenting this information to management, these systems also facilitate managers' and/or dispatchers' monitoring of individual drivers performance, further strengthening the control of driver behaviour.

To summarize, although aware of potential resistance, managers viewed use of technology to increase control of the geographically dispersed and highly mobile workforce as beneficial.

4.4 Inform decision making

Many of the managers interviewed argued that making decisions was a crucial part not only of their work but throughout the entire organization. However, the nature of the decisions to be made differ depending on the tasks performed by different members of the organization. Regardless of the actual tasks described by the respondents, technology was seen as a potential aid in various decision-making processes. First, responsible for managing their trucks, drivers were thought to benefit from technology in planning their work. As an illustration, this respondent saw technology as a great potential of improvement:

> *"I've been thinking about some kind of route planning system. We could make money by shortening the driving distance. We should have a system keeping you from driving under a bridge that is too low, or ending up on a road where you're not allowed to drive because the truck is too heavy. And maybe the system could take into account the traffic situation as well. I think they can do that nowadays."*

Second, dispatchers were assumed to have great use of technology in making their daily decisions. The mobile nature of the main resources to coordinate (trucks and drivers) made the available information on their positions and

activities short lived. One respondent made clear the role of technology as decision-support when discussing how dispatchers would benefit from a constant flow of timely information:

> *"A dream would be to have a complete map over the whole district. Then you could see the vehicles, how they move, and how much cargo they carry. That would have been perfect, it would make their job so much easier. Although you can never replace humans, a lot can be done to assist a person in taking decisions and making choices."*

Third, bearing similarities with the envisioned dispatcher support, vehicle maintenance personnel were also assumed to benefit from technology capable of delivering accurate timely information. Here, the critical information concerned the condition of the trucks. Timely information delivery was argued to ensure optimal decisions on when to service individual trucks, thus preventing massive breakdown and subsequent workflow disruptions:

> *"Having such a system is quite interesting because you can see the condition of the trucks. Consider the Scania trucks, which have had problems with the distributors in the engines. We noticed tendencies before there was anything seriously wrong with the trucks. A closer examination showed that the distributor was faulty, so it [the system] is actually really good."*

Finally, according to our empirical analysis, the distributed mobile nature of road haulage firms makes it difficult to assess organizational performance. Managers relied upon dispersed sources of information in equally disparate formats, ranging from computerized information to paper documents. Respondents frequently lamented the difficulty of making decisions based on incomprehensive, dated, and imprecise information on internal performance. As illustrated in the following quote, technology was seen as a means to make informed decisions:

> *"I think that when you have access to all this statistics [in a system], you could find informative ratios. You earn less on some transports, of course, but it would be interesting to see. If you get a comprehensive view of the costs, including work hours, then you can see how capable and efficient a driver really is. You need to include the cost of salaries when you calculate how profitable a transport is. Costs for service and repairs should also be included, because you need to see when the vehicle is becoming expensive, when it gets unprofitable."*

Expectations of technology as decision facilitator thus varies in complexity ranging from individual productivity tools for drivers, through the time critical coordination systems involving multiple actors, to the organization wide information requirements of the decision-processes of the managers themselves.

5. Discussion

The knowledge of the interviewees in the study ranges from a vague picture of the role of technology support to a clear view of its potential. Expectations among the respondents on technology are high, and they assume a clear impact on business performance in several areas. More specifically, they foremost saw technology as a means to rationalize internal communication, facilitate seamless processes, improve resource control and support decision making. Evident in these expectations is the desire of organizational and technological integration between people as well as the systems they use in an organization, analogous to stated benefits of enterprise systems. Earlier studies of IT implementation and use show that even if there is a strong belief in the potential role of technology, unexpected organizational consequences often diminish anticipated benefits (Henfridsson & Söderholm, 2000, Orlikowski & Hofman, 1997, Robey & Boudreau, 1999). This illustrates the importance of taking into account social as well as technical aspects of the implementation and use of technology in organizations. Focusing on the interaction between the social system that a road haulage firm constitutes and the expectations of technology captured, we extract a set of sociotechnical challenges critical for successful implementation of TIS in road haulage firms.

First, new forms of technology support were perceived as advantageous alternatives to the telephone. More specifically, while verbal communication related to trans-mission of transport order information can be minimized, gathering of vital information can be performed without any form of human interaction, thus increasing efficiency.

In the context of enterprise systems, efficiency improvements are frequently at odds with the need for flexibility in the implementing organization (Nevell et al, 2003). Our study shows that in comparison with the telephone, new forms of communication technology, although viewed as efficient, was also perceived as inflexible and limited to the confines of the organization. This indicates a delicate balance act of fostering efficiency while maintaining sufficient flexibility. As indicated by our empirical analysis, road haulers primarily focus on the positive impact on dispatchers' work situation when considering the effects of improved efficiency. It goes without saying that this tradeoff between efficiency and flexibility also entails social issues. The flexibility of verbal communication offers opportunities for spontaneous conversation. Minimizing the occasions in which verbal communication is needed reduces these opportunities, though. In a longitudinal study Sarbaugh-Thompson and Feldman (1998) noticed tendencies of less organizational commitment in the long run, due to electronic communication within an organization. This indicates that casual conversations facilitate organizational activity by establishing or maintaining relationships between workers. Increasing efficiency by reducing verbal communication may reinforce the solitary nature of drivers' work.

Second, as shown in the empirical analysis, a significant reason for road haulage firms to invest in TIS is the promise of improved efficiency by automation. By

facilitating seamless processes throughout the organization, enterprise systems eliminate manual keying of information from one system to another (Gattiker & Goodhue, 2000). Recent technological advances have brought such promises also to highly mobile transport organizations. In the road haulage context, there are tools that greatly reduce the human effort in dispatching, invoicing, and auditing by ensuring an unbroken flow of information throughout a cross-functional geographically dispersed process. Reducing the manual input in this and other processes will have direct consequences for a number of organization members, the most obvious being potential staff reduction with maintained or increased productivity as a primary goal. In the wake of technological rationalization, reorganization and redefinitions of roles ensues. The nature of such organizational change and its outcomes is dependant on a number of contextual factors (Pinsonneault & Kraemer, 2002). However, it is unclear what IT enabled strategies of structural change road haulage management will pursue.

Third, facilitating control of resources is a vital task for enterprise systems (Markus & Tanis, 2000). Studying the seemingly contradictory empowering and controlling nature of enterprise systems, Sia et al (2002) note that in the absence of explicit management action, the latter will dominate. Constituted mainly of a distributed and constantly moving workforce, road haulage firms are well aware of the benefits residing in technology support for control purposes. The issue of resource control is receiving much attention from systems vendors and commercial packages are available. Supportive features include the real time positioning of vehicles, dynamic information on estimated time of arrival, and available driving time for individual drivers. Providing dispatchers with the means to make an informed decision on who to assign urgent orders to during the day, these features eliminate the need to extract such information individually from each driver. Furthermore, advanced vehicle systems provide the means of controlling working hours. Although beneficial for dispatchers and management, this raises the delicate issue of supervision on behalf of the drivers. Needless to say it is important to consider drivers' reaction towards a scenario where their exact position is available to dispatchers at all times. Our study indicates a concern among road haulage firms about the potential effect on drivers' attitude towards system support. This dual nature of technology on the one hand facilitating work processes and on the other hand facilitating surveillance of employees is a topic previously addressed by for example Orlikowski (1991).

Finally, according to our empirical analysis, employees need differentiated decision support depending on the inherent nature of their work. In addition, the distributed mobile nature of road haulage firms makes it difficult to coordinate organizational activities and assess organizational performance. Bridging the gap of geographical dispersion and mobility, vehicle systems make new sources of potential knowledge available for road haulage firms. More specifically, formalized processing of assignments within the confines of an enterprise system combined with automated instant retrieval of vehicle

performance data facilitated by wireless communication ensure constantly updated sources of timely information. In filtering and combining these sources of information lies the potential of increased understanding of the organization. So far, lack of sufficient information combined with a low degree of integration of existing separate function-oriented systems constitute major obstacles in this area. However, with fully integrated TIS, transport organizations' arduous task of collecting and structuring multiple information sources of disparate format may soon become history. Such transaction records are increasingly regarded as a critical resource in data mining and knowledge discovery (Bendoly, 2003). Indeed, Holsapple and Sena (2003) note that in granting management access to a vast source of information, integrated enterprise systems have characteristics of strategic decision support systems. The nature of the different levels of decision-making in road haulage indicates that drivers need independent productivity tools while management and dispatchers rely on information from drivers. For example, if dispatchers are to gain awareness of the status of ongoing assignments through using TIS, an important requirement is that input of current status into the system is performed by the driver. According to Grudin (1994), motivation for system use demanding additional work is low if there are no direct benefits for the individual expected to perform the work. Although awareness of assignment status is important for efficiency of dispatchers' work, it does not necessarily entail any direct benefits for the drivers. Instead it might be perceived as just another additional task to perform. Such concerns can negatively influence use incentive among drivers, especially in combination with the previously mentioned issues of surveillance and reduced social interaction. However, technology also entails opportunities for improvement on behalf of drivers work situation. Features such as digital maps, route planning, and navigation support may serve as motivating factors. Obviously, an important task associated with the implementation of TIS is to investigate how the technology can entail benefits for drivers as well as utilize the full potential of improvement on the road haulage firm as a collective.

6. Conclusions

Researchers such as Jessup and Robey (2002) and Lyytinen and Yoo (2002) highlight the need for IS research specifically directed towards use of mobile and wireless technology, originating from the changes new technology brings to organizational computing. Recent technological advances have enabled the development of a wide range of applications, supporting daily activities of transport organizations. We use the term TIS to discuss a specific type of enterprise system incorporating applications presenting road haulage firms with possibilities for improvement as well as new challenges. This paper reports a first attempt to investigate expectations of TIS in the context of Swedish road haulage firms. Our findings indicate that these organizations have needs in excess of those addressed by conventional enterprise systems.

Elaborating on the respondents' expectations of enterprise support, we contribute a set of sociotechnical challenges likely to emerge around the implementation of TIS. First, road haulers' strive for efficiency will affect flexibility. Our study indicates that in particular, retaining flexibility of communication is vital both for reasons of formal work processes and social interaction. Second, the rationalizations implicated by the desire for seamless processes will lead to organizational reconfigurations in road haulage firms, the consequences of which are unclear. Third, technology employed for resource control will result in increased surveillance of a previously autonomous workforce. Finally, decision support is seen as critical to several functions. However, the lack of obvious use incentives on behalf of drivers potentially resulting in lack of data quality will severely impair the advantages of such technology.

Further IS research is imperative to comprehend the challenges involved in implementing and using enterprise systems in transport organizations. As noted by Orlikowski and Iacono (2001), there is a need to concretize the technological artifact in order to theorize about its relation to the social context in which it resides. Investigations covering attempts to seamlessly integrate people and systems in transport organizations will illuminate the sociotechnical challenges presented here, adding precision to the experiences pertaining to everyday usage of TIS in this type organization. In view of the multi-faceted emergent nature of TIS, detailed studies of instances of such systems in use would be suitable. Finally, while we have discussed TIS in terms of a comprehensive concept incorporating the enterprise wide needs of technology expressed by road haulage firms, further IS research is needed to concretize the content and preferable architecture of TIS.

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Technologies for value creation: An exploration of embedded systems use in a business model context

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Abstract: *In this paper we delve into the new possibilities that the use of embedded systems can bring to manufacturing companies. We explore what business model is appropriate for deploying embedded systems in business processes, by looking at two high-level models; the value chain model and the value constellation model. Both models are based on the idea that embedded systems allow for a radical 'closeness' to relevant products and their performances, but they differ in how they view the role of the customer in the value creation process. In the value chain model the customer is viewed as a consumer with little influence on perceived value. By letting the technology be part in a value constellation it is possible to let the customers take a more active part in the value creation process, which gives them possibilities to create value by themselves, and move away from the traditional role as consumers.*

Keywords: *Business model, Embedded systems, Services, Business design, Value creation*

1. Introduction

As today's business life is becoming increasingly digitalized due to the pervasive role of new information technology (IT), contemporary organizations need to pay detailed attention to the ways in which IT affects their business processes. While there is a potential to radically change the value creation processes for

organizations by means of new IT, there is no easy route to success. While high-level models, such as the value chain model (Porter, 1985) and the value constellation model (Wikström & Normann, 1994) are well established in information systems and management literature, they give us little or no help in how to deploy IT to enhance business value.

The development rate of IT has been high and the decreased size and reduced prices on sensors and processors together with heightened capacity has made integration of computer technology with products possible; the physical world can be linked to the digital world. (Lyytinen & Yoo, 2002; Pottie & Kaiser, 2000) This development of so called embedded systems has not gone unnoticed and an increasing number of manufacturing companies are expected to see the potential value in adopting new technology and incorporating embedded systems into their products. (Kilbo, Severinsson & Berggren, 2000) The specific application within the embedded system field in focus in this paper is remote monitoring systems. These systems make it possible to monitor equipment from a distance by collecting data and then transferring it to a receiver.

There are many different routes to pursue for organizations deploying embedded systems in their business process. What business model is appropriate for deploying embedded systems in business processes? While high-level models such as the value chain model and the value constellation model can help us in seeking an answer to this question, we also need to pay detailed attention to the characteristics of embedded systems to be able to provide a good answer to this question. To this end, our study echoes the recent call for IS researchers to pay more detailed attention to technology (c.f. Monteiro & Hanseth, 1996; Orlikowski & Iacono, 2001).

Embedded systems are a technology that has potential to change production, products and services connected to products. Products that can communicate and send data to a receiver open up possibilities to collect information about how the customers actually use the products. This information has potential to create new conditions for business processes and value creation. In this paper we delve into the new possibilities that the above-described development can bring to manufacturing companies. In order to reap the business potential of embedded systems an organization needs to successfully deploy the technology in their overall business strategy instead of focusing merely on the IT-use itself. By focusing on the IT-use from a business strategy perspective - as represented in the organization's business model - the technology's business value is examined. The aim of the paper is to explore the value creation processes made possible through the use of new technology. We base our work on two different high level business models; the value chain model and the value constellation model, in order to create an understanding of the technology from a business perspective. The context of the study is a crane manufacturer named MacGregor Cranes.

2. Related research

When seeking to find a viable path to deploy IT in business processes we need to remind ourselves that the design of an IT solution for business needs is not primarily an IT-oriented activity. Rather, business and IS literature shows that it should be seen as the solution to a set of very different types of problems of both social and technical nature (Orlikowski, 2000). It is a crucial dimension to any IT application to resonate well with an underlying business model. Its' role in a business process needs to be made explicit and elaborate, in particular with regards to the role of the customer in the business process. This cannot be accomplished without knowing what the underlying business model for the service is in the first place.

A business model is a term that is often used to describe the key components of a particular business (e.g. Allen & Fjermestad, 2001; Armistead & Clark, 1991; Timmers, 1998; Weill & Vitaele, 2001). However, the empirical use of the concept has been criticized for being superficial and not sufficiently theoretically grounded (Porter, 2001). While we agree with this assessment, we also argue that the notion of business model is too loosely coupled to the distinctive role that IT plays in business processes. But even if Porter's framework has been used extensively within IS research, existing research have addressed high-level aspects rather than the ways in which IT enables or constrains business processes. For instance, McFarlan (1984) suggests that IT can be deployed to affect entry barriers to markets; Porter and Millar (1985) argue that IT can be used to enhance value chain activities to gain competitive advantage through low cost or differentiation; Ives & Mason (1990) argue that IT can be used to enhance customer and partner relationship; and Rackoff et al (1985) argue that IT can be used for achieving cost rationalization and niche positioning.

Porter's *value chain* framework (Porter, 1985) has come to be the dominant model for representing and making sense of firm-level value creation. It can be described as a method for decomposing a firm's activities into strategic units, with focus on their impact on cost and value. Each actor has a specific position in the value chain where they add a certain value and then the product is passed downstream to the next actor in the chain before it finally reach the customer. The activities may differ between different firms but examples of common activities are design, production, marketing, delivery and service. The fundamental concept of the chain is that a product gains value (and costs) as it passes through the different activities within the firm. Profit is generated when the created value exceeds the costs (Hergert & Morris, 1989). Porter (1985; Porter, 1990) argues that while the framework is valid for all industries, the actual activities that prove to be value creating and thus central for a firm's competitive advantage, may differ between industries.

Normann and Ramirez (1993) have outlined a critique of the value chain idea, as presented by Porter. They argue that the traditional view of value creation has evolved from an industrial economy but companies today are however

faced with global competition, changing markets and new technologies that drastically change the ways and conditions of how value can be created. With new opportunities also follows new uncertainties and risks. Actors from previously unrelated sectors can suddenly become strong competitors and change the business by using technology. A company can't be satisfied with their current value creation process. They have to question their own activities and constantly be open minded to new ways of doing business. To succeed under changing circumstances the strategic focus has to be on the value-creating process and not merely on the company or industry itself. The value-creating process consists of many actors – suppliers, business partners, allies, customers – who all work together in order to co-produce value. To meet the new conditions in the environment the process of creating value may have to be changed; the process should no longer be viewed as a chain rather as a *value constellation* of actors. The value constellation model defines value creation as a network of co-participants, each adding value to the other. The focus of attention is not on a distinct business or industry but rather on the whole range of economic actors – suppliers, partners, customers and maybe even competitors – that work together in co-producing value. The roles and relationships in this value constellation must constantly be revisited and value may have to be created in new forms and even by new players. If focus in the strategic work only is on the single company the entire setting of the value-creating process is missed and it becomes difficult to see the opportunities (or threats) in the value-creating process and constellation of actors. (Normann & Ramirez, 1993) Stabell and Fjeldstad (1998) also take a step away from the value chain as they argue that value is created in networks, and firms are depicted as entities "that create value by facilitating a network relationship between the customers using a mediating technology" (Stabell and Fjeldstad, 1998: 414).

Information technology has had a great impact on the value-creating process (Normann, 2001; Normann & Ramirez, 1993). There are two basic processes that the technology enhances; separating activities and resources that used to be connected to each other but also to combine activities and resources that used to be separated. With information technology it becomes possible to separate information from its' physical carrier and thereby value can be created out of the information. Remote monitoring system are an example of information technology that separate the information from the machine and make it possible for the manufacturer or other actors to do businesses out of it. Remote systems are also an example of IT's ability to separate and combine in the same time. The systems do separate information from its carrier - the machines-, but in the same time it combine the manufacturer and their knowledge about the product with the product in a virtual manner. The system does thereby bring together actors that physically are distant from the product and the information transferred helps them act at a distance.

In the following sections we will seek to explore the value creation processes that MacGregor Cranes seek to initiate with their customers, and the ways in which technology is intertwined in these processes.

3. Method

The paper is based on an interpretive case study (Klein & Myers, 1999; Walsham, 1993) conducted in the spring of 2003 at MacGregor Cranes, a world-leading manufacturer of different types of cranes used in the shipping industry. By using participatory observation (Klein & Myers, 1999) we followed the initial discussions about designing and installing an embedded system into MacGregor's cranes as a means of creating new business processes and added customer value. The case study was done over a six-month period, during which there was ample time to meet and get to know the people at MacGregor Cranes.

We used semi-structured interviews and document reviews followed by group discussions with different actors as the main ways of collecting data. (Yin, 1989) We interviewed four members of the staff, three from the after sales department, and one developer in the technology department. Apart from the interviews we were invited to sit in on five meetings focused on the development and implementation of an embedded system in the company's cranes. The meetings were comprised of people from MacGregor Cranes, but the composition of the group and the number of people in it varied between meetings. There were usually four or five MacGregor representatives, ranging from technical staff to service personnel and after market executives, and three of us present at the meetings. After the study was conducted we discussed the results of the research and possible development strategies with the MacGregor representatives.

In this paper, we have chosen to focus exclusively on MacGregor's representatives' accounts of their business processes and thereby excluded the customer's point of view. This, however, is also indicative of MacGregor's own development processes which tend to be technology driven and based on what the organization's representatives see as needs that the customers have expressed or solutions that would create value for the customers. That is, they base their own projects on staff experience, not on first hand contact with specific customers.

Based on the empirical data, we identified pervasive problems and possible solutions and presented these in two different models. The data was then analyzed by discussing the models in relation to the theoretical knowledge of the value creation process.

4. MacGregor Cranes

MacGregor Cranes is a manufacturer of different types of cranes used in the shipping industry. The company is a part of the larger MacGregor Group that includes manufacturers of hatch covers, shipboard elevators, galleys etcetera. MacGregor's head office is located in Örnsköldsvik, a city in the northern part

of Sweden. In 2002 Cranes had approximately 150 employees and a turnover of SEK 649 million. The company only offers business-to-business services and does not have any individuals as customers. Since the customer vessels travel all around the world, MacGregor has an extensive service organization, with offices in 50 different harbors.

Service and maintenance of cranes is the indisputable biggest business in the after sale sector for MacGregor Cranes, even though they currently only service about 20 % of all cranes they have manufactured. The company views service agreements as an important tool in creating a strong relationship with the customer, and therefore strives to increase the number of signed agreements. However, the customers do currently not seem to find any value in signing an agreement with the company. Instead they often turn to local technicians with lower prices when a problem arises. The main part of all maintenance that the technicians perform is therefore done when urgent problems arise at the ships.

4.1 Problems related to after-sale services

The after sales department at MacGregor Cranes is continually working towards extending its market share. This is done in part through selling spare parts and upgrades, but mostly through service and maintenance. The main goal for the service organization is to minimize operational hold-ups as a result of the cranes not working properly. By keeping the up-time on a high level, value is created for the customers. However, MacGregor staff experience a number of problems connected to performing satisfactory service and maintenance. We have chosen to list these problems and divide them into two categories; external problems, that have to do with the customer's organization, and internal problems, that are tied to MacGregor's own service organization. By creating solutions and offers that could solve or reduce the identified problems, value can be created.

4.1.1 External problems

- *Division of responsibilities*: The ships are divided into different areas and different persons from the staff are responsible for a certain area. This means that non-technical staff has the responsibility for servicing the crane, without having the appropriate education and knowledge for the job. This often leads to neglected or badly performed maintenance.
- *A complex way of information handling*: It is not always the person who MacGregor is in contact with who has observed an error in the first place; often the information is mediated from the crane driver to the helmsman, who in turn might report it to the ship owner before the information comes to MacGregor. Because of this, the information

is often brief and sometimes distorted. At MacGregor this results in endless phone calls, faxes and e-mails to and from the ship with complementary questions in order to get more information about the error.

- *Errors go undetected or unreported*: The person driving the crane is a docker, who is hired temporarily when the ship is in port. Consequently, the crane driver does not have any responsibility for the crane's functionality, which means that there is no guarantee that any problems will be reported to the helmsman. Since the crane will have a new driver in every port, it could be difficult for the temporary driver to discover or identify any error. An experience that the technicians at MacGregor have is also that the members of the ship's crew do not often climb up the crane and check the parameters in the control system, which makes it hard to detect problems early on, before something really breaks and the crane stops working.
- *Language problems*: Since MacGregor Cranes operates in several different countries and cultures, and has contact with people of various technical backgrounds, there is the possibility that language barriers arise, which makes the error identification process more difficult. If the problem can't be solved over the phone or via fax or e-mail, a service technician is sent to the ship. This is an expensive solution for MacGregor, and it is important that the communication has been satisfactory so that the technician does not bring the wrong tools and spare parts with him.

4.1.2 Internal problems

- *Time leakage*: Many of the technicians, especially at the head quarter have a long background in the company and have created long lasting relationships with the customers. This also means that when problems arise, the customers call the technician directly, instead of the support desk. The technicians we have met all admit that they spend time giving the customers free support via phone and e-mail. This kind of service does not generate any direct incomes, but could however contribute to goodwill, which is difficult to measure.
- *Knowledge recycling*: Today MacGregor has the beginnings of a kind of database which consists of logs that the technicians send to the head quarter after every visit to a crane. This kind of information is for example valuable if MacGregor finds out that many cranes from the same runs have common errors. However, the database is not being used to its full potential and updates are slow.
- *Feedback from the field*: Today it is difficult for MacGregor to get feedback from the field about the cranes' conditions and how they

are used. This kind of information is valuable in product development since it helps to design cranes that meet actual needs and usage. When new cranes are developed it is also important to really know that they are working correctly and today they do not have any sufficient way of gaining regular comments from the field.

4.2 Technology

MacGregor Cranes has taken the first step towards the use of embedded systems through the development and use of the crane control system, CC2000, where sensors register data about the crane's condition and usage. Today the system can signal an urgent problem directly to the crane driver, but the system doesn't analyse the data or draw any conclusions. CC2000 only registers and detects a fraction of all errors that may come up. Apart from more sensors, a communicative component that can transmit data from the crane to the right receiver should be implemented.

5. Two business strategies

In this paper, we have outlined two business models as two distinctively feasible ways in which to pursue the deployment of embedded systems in business processes. These models are based on two high-level models - the value chain model and the value constellation model. Since embedded systems are a technology that brings with it a potential to change production, products, and services connected to products, we have also sought to pay a particular attention to the distinct character of embedded in the design of these two models. The solutions are thus based on the technological possibilities and limitations, for instance how data is transported, where the processing power should be, and who has access to the data. Consequently, in the first solution the system is connected directly to MacGregor Cranes, which in turn can send data back to the ship. In the second solution the system is connected directly to the Ship's Office, where the technical management is located, and which in turn can send data to MacGregor Cranes when needed. Each solution will result in different streams of information and lead to different business processes, and accordingly solve different problems. The first model leans towards a more traditional view of the value producing processes as a value chain, whereas the second model is formed as a value constellation where MacGregor Cranes creates a network with the customer and the technology and as a result involves the customer in the service organization and value creation process.

5.1 Model 1: A value chain model

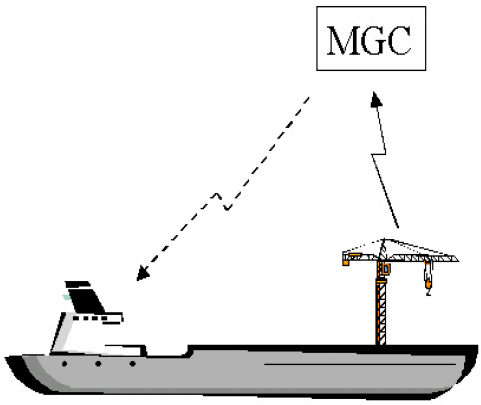

Figure 1. An Embedded System Connected to MacGregor Cranes

In this model the crane is provided with sensors that register data about the crane's condition and then transfer it to CC2000 where the data is stored temporary. The sensors do for example register data about the temperature, pressure, speed of the crane and the time of use. The control system is in turn provided with a GSM modem or a satellite modem, which makes it possible to transfer the data to MacGregor Cranes. Today, the only way of getting direct information about the cranes' condition is by physically being there. Since it is very expensive to send a technician to the ship, many customers are reluctant to pay the price for service from MacGregor and turn to a local business instead. With an embedded system it is however possible to monitor the equipment at a distance. This has the potential to dramatically reduce costs in the same time as new kind of data is collected with the sensors, and taken together this makes it possible to calculate on new kinds of offers.

With data about the crane's condition it is easier to decide when there is a need for maintenance and the system may even disclose which component needs to be serviced. This opens up for preventive maintenance, which is valuable for the customer since operational hold-ups are very expensive. Urgent problems or errors could be discovered by occasional readings of different parameters but preventive maintenance is based on analyses of longer time sets. Through access to data from many occasions it is possible to analyse trends, which makes it easier to draw conclusions about what might happen; maintenance can be based on actual needs instead of on educated guesses.

The most obvious way of using the technology in the creation of new business offers with this solution is to incorporate it into traditional service contracts where MacGregor offers services based on monitoring of the crane. It also opens up for new types of service agreements, for example extended warranty if the customer lets MacGregor take care of all maintenance. Another more

internal benefit of sending operational data directly to MacGregor is the possible use of data in product development. Potential product problems can be detected early on and avoided in further production.

Earlier we described a number of problems that the staff at MacGregor experience. In the table below we list the problems and if they are handled by this solution in some way.

Problems	**Influence**
Division of responsibilities	No
A complex way of information handling	Yes
Errors go undetected or unreported	Yes
Language problems	Yes
Time leakage	Partly
Knowledge recycling	Yes
Feedback from the field	Yes

Figure 2. The solutions' potential influence on experienced problems

The remote monitoring system in this model could create value both for the customer as well as for MacGregor. The most obvious value to the customer is the potential of minimizing operational hold-ups. The technology could also be helpful in solving many of the problems described earlier that MacGregor experience today. The complexity of information handling could be reduced since MacGregor gets direct access to the data instead of receiving it indirectly after it has passed many persons. The regular monitoring of the crane also reduces the problem with an external person operating the crane, since problems can be detected even if this person does not report them. Language problems could also be reduced due to the direct access to the crane data. The problem with time leakage could partly be reduced since the time it takes do analyses will be charged and the time it now takes to search errors can be reduced with the direct access to data. By opening up the possibility of preventive maintenance, the planning horizon at MacGregor can also be lengthened, which would provide the company with a more manageable service organization. The feedback from the field would definitely be improved with this solution and the data could be a good source for knowledge recycling since it can be stored and used when future problem arise.

5.2 Model 2: A value constellation model

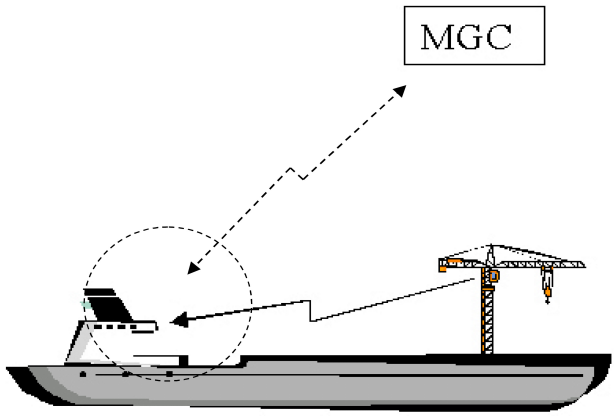

Figure 3. An Embedded System Connected to the Ship's Office

As in the first solution the crane is provided with a number of sensors that register data about the cranes' condition. These sensors are connected to CC2000 were data from all sensors are collected. What differentiates this solution from the previous is that the control system is connected to the Ship's Office instead of to MacGregor Cranes. Data is thereby transferred from the crane to the technical management located in the office. In the Ship's office there is a computer that receives the data and where analyses is done. This computer is also provided with a modem that makes it possible to send data to other parties. With this solution there is no direct communication channel to MacGregor; they can only receive data indirectly via the ship if the customers choose to send it away.

The purpose of using data to provide preventive maintenance will remain even in this solution but focus is put on improving the customer's own service organization. The system is used to provide the customers with better and more information about their own equipment and this will be valuable from a learning perspective. MacGregors' role will be to assist the customers when a problem arises that they can't handle or identify on their own. The data will be a good base for MacGregor too and the customers could send it over to MacGregor when needed. As in the first model MacGregor does not intend to sell the system, instead it is to be incorporated in some kind of service agreement, with the purpose of creating a long lasting relationship with the customers.

The remote monitoring system in this second model mainly creates value for the customers by minimizing the number of operational hold-ups. This second model does however also provide the customer with a better surveillance of his own crane. Instead of only providing the customer with a crane, MacGregor

provides a new potential way of organizing the information flow, so that it is directed towards the right person. The system also creates value by allowing the customers to learn more about the crane since they have direct access to the data. In addition, the system also helps reduce some of the problems presented in section 4.1. Below follows a table that shows how this way of organizing the data flow influences the earlier listed problems.

Problems	**Influence**
Division of responsibilities	Yes
A complex way of information handling	Yes
Errors go undetected or unreported	Yes
Language problems	Yes
Time leakage	Partly
Knowledge recycling	Partly
Feedback from the field	Partly

Figure 4. The solutions' potential influence on experienced problems

The experienced problems with the division of responsibilities could be reduced with this solution. When the data is transferred directly to the Ship's Office where the person with proper technical knowledge is located, appropriate action can be taken. The information handling will not have to be carried through many different organizational layers, which reduces the experienced complexity. Since the system allows the technical staff in the Ship's Office to monitor the crane, the problem with errors being undetected or not reported because of an external person operating the crane could be reduced. The language problems could also be minimized since the data serves as a good base in the process of seeking errors. By improving the process of seeking errors, time spent on that today can be reduced, which partly reduces the time leakage at MacGregor. In this model, MacGregor won't have a direct access to the data; they will only receive data occasionally when the customers choose to provide them with it. Thereby this model doesn't provide them with the same opportunities to get feedback from the field and to recycle knowledge. The planning horizon will with this solution be longer since the focus is on preventive maintenance instead of urgent problems.

6. Discussion

The above described models provide two different ways of looking at and organizing value creation. They also provide some insights as to the role of technology, in these processes. However, we feel that there is a danger in

only focusing on the potential benefits of the incorporation of new technology and in this section we therefore expand the view to include potential risks associated with such a development.

6.1 Value Creation

We have described two business models that can be used to identify various decisions and issues that need to be addressed when deploying embedded systems in business processes. While both models are based on the fundamental premise that embedded systems will bring a fundamental shift in business processes by relaxing the time-space constraints and 'closeness' to relevant products and their performances, a central difference between the models lies in that the customer and his needs are more central to the second model (based on the value constellation notion) than the case is with the first model (based on the value chain notion).

In the first model the information flows in a rather linear fashion. First the data is collected at the crane, then it is sent to MacGregor Cranes where it is analysed and finally the results are delivered to the customer via a report or a maintenance occasion. In the second model the system transfers the data from the crane to the Ship's Office where staff in the customer's organization, who have the best knowledge about the crane, are located.

What differentiates the second model from the first is clearly the shifted view on the customer. Instead of transferring data away from the ship and over to MacGregor the data is kept and partly analysed on board where the service actually has to be performed. Focus is mainly on the customer's own way of organizing information and maintenance work and the business process therefore mainly takes place within the customer's organization, although it is in collaboration with MacGregor. The real value is not created until the data is received and incorporated in the customer's work process. The customers are no longer just a consumer of value, instead they are supposed to take an active role and be part of their own value creation process.

In terms of problem solving, we have seen that both models offer solutions to a range of experienced problems. Both solutions have the potential to create value to the customers by reducing the number of operational hold-ups. However, the first model, which is based on the value chain, can be said to create more direct value for MacGregor as it solves all of their internal problems. The second model has a clearer focus on the customers and solves the experienced external problems, while partly solving the internal problems.

6.2 The Role of Technology

The role of technology varies in the two models. In the first model, MacGregor uses the technology as a mean to gain access to data. By using their knowledge

they transform this data into insights and offers that should create value for their customers. Although new offers and new kind of values could be created with the use of embedded systems the value creation process in this model is organised and viewed in a traditional way; in the spirit of the value chain. The activities take place in a linear fashion and different actors add value until the product or service finally reach its customer. Incorporation of technology as described in this scenario into the service process does therefore not fundamentally change the process; instead new technology improves *the way of doing it*. The customer has a rather passive role and their role in the value creation process is best described as a *consumer.* This is rather natural position for the customer in a value chain since they are the last outpost and receiver of the product.

The second model, however, uses technology in a way that differs from how MacGregor traditionally have designed business offers based on technology. Instead of only improving the way service is performed, the technology allows for a new flow of information that puts focus on the customer and his own service process. MacGregor Cranes creates a network with the customer and technology, and as a result involves the customer in the service organization and value creation. The customer is hence not only a consumer, but a *co-creator* of value.

Since embedded systems can mediate data that has not been accessible earlier the system gives the receiver an increased quantity of information that can serve as a base for development of new kinds of services. Through services based on real information about the activities, different benefits could be reached, for example saved costs and less risky and improved services. The manufacturer often has a good basic condition to analyse and draw conclusions from data since they have long experience with and knowledge about the product. Developing new services based on product data could thus be a new way for manufacturers to gain benefits of their knowledge and get paid for it.

6.3 Potential Risks

There are also potential risks associated with the use of new technology for service purposes, especially when developing a remote monitoring system that is based upon the idea of direct access to customer data. Earlier research shows that in order for technology-enabled service processes to be successfully implemented in the customer organization, it is important that the service provider understands the perceptions and perspectives of the customers. (Walker & Craig-Lees, 1999) Otherwise there is a risk that the use of technology will depersonalise the service experience, and cause frustration with the customers. (Walker & Craig-Lees, 2000) This is an interesting point to consider since MacGregor's own development process stems from its staff's perceptions of what the customers regard as value adding, instead of from the customers themselves. This could potentially mean that they end up developing a product that the customers do not want or need. We therefore suggest further studies in which the customer perspective is prevailing.

Our research framework also recognizes the necessary and critical feedback loops that are involved in the adoption of embedded systems, i.e. we assume that different organizations will react differently to the presence of the technology. While some organizations are likely to welcome the technology for the enhanced possibilities it can enable, other organizations are likely to feel threatened by the technology due to the risk of surveillance. Since the use of a RMS is based on data logging, it also means that it is possible for MacGregor to detect incorrect use of the crane, or neglected maintenance. This might not be a selling argument to those customers who would feel monitored and supervised. However, it might also be something that the customer organization would regard as valuable as they themselves can use the system to make sure that their own staff performs its duties in a satisfactory manner. It is important that one does not forget the question of integrity as this can have a major impact on how the system is adopted.

A third risk associated with the second model is that in a value constellation setting the customer has direct access to the data that the RMS provides. This also means that they can enlist the aid of other service organizations to analyse the data and perform service. That would imply that MacGregor could potentially lose customers due to the arrival of new actors that use the technology for their own benefit. This can partly be handled in service agreements, but is a potential risk.

7. Conclusions

The aim of the paper is to explore the value creation processes made possible through the use of new technology. We have done this by exploring two different business models. These models are based on two well known high-level models - the value chain model and the value constellation model. It is our belief that these models can be used to identify various decisions and issues that need to be addressed when deploying embedded systems in business processes.

Our study underlines how profoundly technology is intertwined in the value creation processes. Technology has the potential to change the way value is created, through a network of co-participants and technology as suggested by Normann and Ramirez (1993), instead of a traditional linear chain of value-adding activities as proposed by Porter (1985). By letting the technology be part in a value constellation it is possible to let the customers take a more active part in the value creation process and it even gives them possibilities to create value by themselves and by that moving away from the traditional role as consumers. It is however important that the supplier creates strong relationships with their customers so that the knowledge embodied in the technology remains within the constellation. Otherwise the supplier might lose market shares to competitors that take advantage of the system's properties and uses them to create own services and offers.

Merely focusing on the IT-use itself could hamper the potential business value of embedded system since it may direct the attention to the actual usage setting instead of the usage in an overall business strategy. In this study we have seen that the technology allow firms to deploy a business model with an underlying strategy of getting close to the product and to the customer. Getting closer to the customer is however not something that is merely made possible by the use of technology, but embedded systems do stress a development in that direction. The two solutions outlined here includes not only goals and benefits with the business but also a particular use of the technology – an aspect that is important to include in a business model based on IT.

Looking at the models and their underlying assumptions we find that both models are based on the idea that embedded systems allow for a radical 'closeness' to relevant products and their performances. This closeness can also lead to a number of issues related to integrity as it opens up for monitoring usage. In order to not lose the value that each model creates, it is important that one takes into consideration each customer's perspective since they might react differently to the system's full potential.

This process of developing the models and introducing them to the customers has now been initiated at MacGregor Cranes, which opens the door for further research in this area.

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A Narrative Mode of Change Management

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***Abstract**: Change projects put a high demand on people's ability to change mindset. It requires motivation and commitment to take on another perspective than the existing one. Common methods like BPR, and TQM, tend to fail in motivating and engaging people sufficiently to reach the goals. In this paper we outline an alternative method for driving change management. We propose the use of myths, tales, and stories as triggers in change projects in order to create a creative and dynamic atmosphere in which change can be achieved. Even though there is by now a rather substantial literature on narratives in organization theory, very little research has focused on narrative as a vehicle for change and organizational development. Myths are interesting because they serve as a tool for formulating and recapturing a worldview; they integrate people into organizational culture and they can guide people in their individual psychological development.*

***Keywords**: Change Management, Narratives, Myths, Action Research, IT-Consultants.*

1. Introduction

Change projects put a high demand on people's ability to change mindset. It requires motivation and commitment to take on another perspective than the existing one. Common methods used today like process management, Business Process Reengineering, Total Quality Management, and Six Sigma do not reach expected goals (see e.g. Kotter 1993). These methods fail to motivate and engage people sufficiently to reach the goals.

In this paper we outline an alternative method for driving change management work, based on the use of narratives. The overall research question is:

> *How could we use myths, tales, and stories as triggers on group level in workshop situations in order to create a creative and dynamic atmosphere in which change can be achieved?*

Even though there is by now a rather substantial literature on narratives in organization theory (e.g. Czarniawska, 1997; 1998; Boje, 2001; Gabriel, 2000) very little research has focused on narrative as a vehicle for change. Myths are interesting for change management and organizational development because of their three basic functions: they serve as a tool for formulating and recapturing a worldview; they integrate people into organizational culture; and they can guide people in their individual psychological development (May 1991).

In an ongoing action research study we investigate how stories and myths can be used as a method to create a creative and dynamic organizational culture during a change project and thus be a tool for managing change processes. The context of the study was a merger between two consultant companies, where one of the key issues was to create motivation and engagement for integrating the different organizational cultures to one, both as viewed internally and as seen by customers.

Myths and stories were used as triggers to create an atmosphere devoted to creativity and motivation surrounding the change project:

- by listening, describing and analyzing myths and stories to challenge the old mindsets.
- by using the form of myths and stories to describe problems and challenges the organization was struggling with.
- by visualizing myths and stories in the form of drawn pictures to find new ways of communicating change to the project participants.

In our study, the organizational change assignment at hand was combined with exercises that were conducted both at group and individual level, to enhance participants' ability as storytellers and to increase their understanding of the basic structure of myths. The objective of this method was to reach individuals within an organization via external communication, through stories, myths, and tales. The result is that the change process is driven by and perceived as a myth. The myth in question will share the same elementary building blocks as, for instance, a classical Greek myth (Campbell 1973). Myths as bearers of insight are particularly powerful since people are affected by myths on a much deeper and subconscious level, giving rise to an effective inner communication.

The paper is outlined in the following way. First we introduce the concepts of change management and motivation. Then an overview of myths and narratives is given in relation to organizational and change management issues. After that a section on method follows. Then the research case, the experimental change project, is presented and discussed. The paper ends with conclusions.

2. Background

2.1 Change Management

Change is a central concept in business and management. It is a broad term closely linked to concepts like organizational restructuring, transformation and development. One can think of change as monolithic and revolutionary, differentiated and incremental, or invisible and continual. Even if change and change management is not addressed explicitly, it is a vital part of most theories, methods and approaches dealing with organizational development.

What really made change efforts explicit and central for many consultants and practitioners was the trend of process orientation that started in the early nineties (e.g. Davenport and Short, 1990; Heygate and Bebach, 1991) and further developed to the popular Business Process Reengineering (BPR) approach (Hammer, 1990; Hammer & Champy, 1993).

Here the process is seen as the heart of the organization, and the process must create value for the customer. In the process oriented organization, all activities related to a task are managed as one single operation performed by an individual or a dynamic customer-focused business team (Womack et al., 1990; Hammer and Champy, 1993; Keen, 1991). However, the approach was criticized for not living up to its expectations, it tended to underestimate the impact of culture and the process maps were often too idealized to work in practice.

Another wide spread approach is change specifically focusing on quality, like TQM and similar approaches that seek incremental and continuous improvement of established work practices (Hackman and Wageman, 1995). From the beginning quality was seen as equal to a number of deficiencies. Quality was a measure of number of errors for each produce unit. Over time quality came to mean functional quality, i.e. the function they fulfilled for the customers. Today quality is often discussed as perceived quality, i.e. quality is about satisfying the customers' need at lowest cost. Also TQM has been criticized, e.g. for generating bureaucracy and for making organizations slow to change (see e.g. Hackman and Wageman, 1995).

Yet a widely spread consultant approach is Six Sigma, a tool to drive changes in quality work and cost reduction. By reducing costs, shorten cycle times and increase customer satisfaction the productivity is optimized. The method means that a measure based work practice focusing on process enhancement is introduced (Eckes, 2001).

Despite all different approaches there is a high rate of failure in change projects. Most of these perspectives are based on a rationalistic and mechanic worldview, underestimating the complexity of change, the strength of people's attitudes and values and the importance of having a shared meaning. Among

the most important reasons for failures are the lack of visions, failure in communicating the vision, and failure in making the employees committed and to underestimate the role of culture (Kotter, 1993).

By instead taking a social constructivist perspective the whole organizations' beliefs, interpretations and opinions are taken into account. The challenge is to understand how "institutions think" (Douglas 1987). Here focus is not on the employees' behavior per se, but on language, or what Morgan calls management of meaning (Morgan, 1996).

2.2 Motivation

People's motivation is important for change efforts to succeed. How do you motivate people in a change process? Motivation is the driving force that is supposed to make individuals act and behave in a certain way.

There are a plethora of theories of motivation. Some of the most well known are Maslow's hierarchy of needs (Maslow, 1970), and Herzberg's (1966) two factor theory. Maslow's hierarchy of needs consists of lower order needs that are satisfied externally (physiological and safety needs) and higher-order needs that are satisfied internally (social, esteem, and self-actualization needs). Herzberg's two factor theory relates intrinsic factors (motivational factors) to job satisfaction and extrinsic factors (hygiene factors) with dissatisfaction. Intrinsic factors are achievement, recognition, acknowledgement, responsibility, work itself if it is stimulating, and self-actualization. Extrinsic factors are company policy and administration, management, work conditions, production arrangements, salary, relationships with management, peers and subordinates. In change management approaches, a focus on extrinsic motivation is the most common. However, extrinsic awards for behavior tend to decrease motivation, especially if the behavior was previously rewarded intrinsically.

Thus, to motivate people to take active part in a change process, and to change their own behavior, both their intrinsic and extrinsic factors for motivation are important.

Despite this, in most change processes it is mainly the extrinsic factors that are focused. Because of this people do not become deeply engaged. To achieve commitment and engagement from people in change projects one need to focus much more on what motivates people intrinsically.

The change management facilitator must therefore inspire and create the intrinsic motivation among people by building on their own values. This requires three things: First to be clear about the expected results and values in the change project, second to have a clear and understandable change vision, and third to be aligned with the values of the people to be lead. To understand individual's values and attitudes is important in order to create a change friendly climate and to motivate people to change.

People's values and the culture are important factors in the resistance or engagement to change. Individual norms, work practices, dress code, attitudes

to customers and the company are all part of the culture of a company. Culture is often a ”function” of the history, its high profiled employees and leaders, its most important events. Company policies and strategies are ways to communicate what the management regards as ”good” values. Values could also be communicated by symbols, metaphors and narratives. One instrument for change facilitators is therefore myths, stories and fairy tales, since they embody value systems and norms (May, 1991).

3. Myths and Narratives

3.1 Myths

Myths, tales and stories are recognized in all societies and times as bearers of wisdom as well as norms and values. They are often understood to bear almost archaic knowledge about the human psyche. Myths, tales and stories can also be seen as an active intermediary for analyzing and reflecting over situations. A myth or a tale can create meaning in a situation that otherwise might seem meaningless. It has therefore been natural to connect myths and stories to processes of change. Myths are story-patterns that can guide groups and individuals in times of change.

This has made myths interesting for scholars dealing with organizational issues. A myth can be seen as a drama that starts with a historical event and advances into a new character as a method that guides co-workers and help them orient themselves in the world. From an organizational point of view myths have been seen as a way to promote the organization’s values and norms and also as a way to tie workers to the organization and its goals and values by providing a sense of identity and connectedness with the organization (Snowden 2002).

Myths and stories tend to promote entireties more than the specific. They can combine conscious and unconscious dimensions of human experience. Myths can blend past and present, individual and societal which is staged in the form of a story that is passed on from one individual to another in an organic and ad hoc fashion. While empiricism addresses “objective facts”, myths and stories speak to human experience in a social or organizational context.

If an organization is regarded as a process, change work becomes sub-processes within the overall organizational process. Myths and stories can be used as a way to express experiences and thereby help members of the organization think, feel, become conscious and react on the change, co-workers and their own role in the process.

Myths as guides in change work are interesting because:

1. They support identity creation by answering the question ”Who am I?” An example of a corresponding myth is Oedipus trying to figure out who he is.

2. They create a sense of connectedness: Oedipus gathers his men in the war against the Trojans.

3. Myths can support moral and ethical values. Mythical stories are often about good and bad, what actions are respectable or not.

Even if a myth is old, it can still be used in modern organizational change work. Myths seem to address archetypical human cognitive patterns. Campbell (1973) argues that a person often can relate to a myth even if he is not previously familiar with it. Anthropologist Claude Lévi-Strauss (1995) even suggested that myths talk through man without him knowing it. To that we can add that myths, even ancient Greek myths or variants of them, still are retold or referred to in everyday situations, which seems to be an expression of their relevance. This does, however, not mean that they are interpreted the same way today as in history. On the contrary, myths are reinterpreted on the basis of actual circumstances, which also is important for explaining why they still are relevant. We have to think about myths as tools for making sense of the world based on generally accepted concepts like "the hero" or "the enemy".

Myths can speak about organizational entities, such as a family or a company. By starting the other way around, and relating an organizational entity to an appropriate myth, it can help seeing and understanding roles and social interplay within this entity as well as in relationship to the surrounding world. Myths and stories have an important role in the social construction of reality and the social construction of change and incitements for change. It is therefore not surprising that scholars such as Paul Ricoeur (1985, 1988) who discuss literature and Barbara Czarniawska (1997, 1998) who discuss organizations understand stories and myths as a way to recognize social life in itself. Myths create both familiarity and distance.

3.2 Roles and plots in myths

In today's organizations teamwork and continuous learning is important. Most decisions are not made by a single person, and teamwork is a common way to make evaluations and solve problems. Organizations are characterized by diversity, internal competition and conflicts around power and prestige that can become threats against long-term future strategies. Still members must strive towards a common goal. The myth of Protheus is an example of a myth that addresses modern firms and their dependence on change as well as consequences of change for the members of the organization. The Greek god Protheus represents the myth of change. Every time Protheus enters a difficult or dangerous situation he alters to another shape that gives him protection – a tree, an animal or an insect. Based on this myth one can talk about a Protheus-like way of dealing with change, threats and complexity. Campbell (1973) has shown the uniformity of myths from different parts of the world, what he calls the monomyth. Campbell's example is myths about the hero. The plot is organized around three stages: "separation", "initiation" and "return". Typical

roles are prince, king, queen, princess, trickster, guardian and helper. The roles support the plot that is moving through the three stages: the hero gets a call; he has a helper at hand; the hero is tested by having to solve a number of tasks, e.g. dragon-fighting, crucifixion, finding the elixir. At the end the hero returns and saves the princess.

Such a myth can be used in an organizational context to raise consciousness about strategies to solve problems, showing best practice, i.e. to organize change work. By using myths a creative situation can be established that will help team members to deal with old problems in a new and unexpected way. Establishing a mythical way of organizing people can be a way to reduce immediate and practical problems, and thereby opening up for possible solutions.

3.3 Using mythical symbols as change agents

The symbolic dimension of social activities is quite easily related to symbols used in myths. Symbols in myths have been discussed in a wide variety of research contexts, such as linguistics, philosophy, anthropology and semiotics (e.g. Levi-Strauss 1966, 1995; Barthes 1997). However, it is important to separate signs from symbols. A sign has a relatively fixed meaning while a symbol is more open and related to other symbols. In a myth context the symbol is connected to roles and plots. The symbol feeds sense making in an associative figurative fashion and becomes related to individuals' backgrounds, experiences, personalities etc. Using symbols as change agents takes advantage of stressing the open associative dimension, not reducing symbols to fixed signs.

Using symbols in myths as change agents means to draw on myths as a narrative that contains time, action, actors, goals, threats and solutions. An important factor in change work is to understand how people act in a period of turbulence. Based on prototypical myths the following change agents can be identified as symbolical resources for change work:

- The Antagonist: The evil, the villain with whom the hero finally has to fight. E.g. troll or an evil queen
- The Giver: Those who put the hero to a test, give the hero a magical object
- The Helper: Assists the hero when it really matters
- The Wanted: The beautiful princess who disappeared, marries the prince
- The Hero: He who decides to act, accepts the challenge, who wins and ascends the throne
- The Mandatory: He who encourages the hero to act, requires the assignment carried out, abundantly rewards the one that carries the assignment. E.g. King or Queen

- The Delusive Hero: Believes himself to be at his best, claims to have carried out a heroic deed, looses by being exposed and punished. E.g. The Looser

These actors can be related to a set of basic tasks or situations that occur in myths as well as in organizational change work:

- Predicament: The problems the actors try to solve
- Intentions: What the actors try to do
- Actions: What the actors do to achieve their intentions
- Objective: The tools the actors use.
- Causality: The effects (both the predicted and unpredicted) of realizing the acts
- Context: The many details surrounding the actors and the acts
- Surprises: Everything unexpected happening in the story.

The different roles are actants in the model corresponding to the action-models (or functions) that the actants might pursue according to a certain plot. These models were also the one used in the research case described below.

4. Method

4.1 The setting

During 2003 the consulting company Guide acquired Astrakan, a similar but smaller consultant company. Both firms are known for being strong brands and having competent and professional consultants. It was seen as important to merge the two companies in a way that made the Astrakan personnel feel really welcome to Guide. Therefore a special unit with 35 persons was set up to work with the integration process. 16 people in this new unit came from Guide and the rest from Astrakan.

The two companies were quite similar, however, the core business idea was different. Astrakan was used to short projects, teamwork and in house jobs, while Guide usually created long term recurring relationships with their customers and worked with the customer at their site. At Guide there was a focus on creating dynamics, working with responsibility and having "fun at work". Astrakan had focused on entrepreneurship, competence and theoretical work in developing methods. The idea was to merge these two organizational cultures into one that integrated the best practices from both.

4.2 Using narratives in action research

The integration project, which was launched during autumn 2003, was set up as collaboration between the two organizations. The goal was to make people from the two cultures act as a team in order to generate synergy effects and creating a new work atmosphere that was characterized by creativity. This was done by focusing on the development of a new price model for projects using narratives as a main method. The project can therefore be described as an action research case where change management work is accomplished with the use of narratives.

Action research is described by Levin (2002) as a way to increase the knowledge about social systems by trying to change them. This is done through systematic attempts to develop organizations and decrease the distance between theoretical knowledge and practical work. Action research promotes testing a theory or a method on a real case to understand the practical implications of the theory or method and to provide a solution to a specific problem.

An important step in action research is to establish cooperation between the researchers and the practitioners involved by building on mutual trust and exchange of reliable knowledge. In this case one of the authors is an industrial Ph.D. student who is also working at Guide as a consultant (in the following we refer to her as "the facilitator"). This made it easier to establish the collaboration, and created a possibility to try a narrative method in practice, in the form of an experimental change project.

Here myths, tales, and stories were used as triggers on group level in workshop situations as a way of creating a creative and dynamic atmosphere in which change management work could be conducted:

- by listening, describing and analyzing myths and stories to challenge the old mindsets.
- by using myths and stories as a form to describe problems and challenges the organization is struggling with.
- by visualizing myths and stories in the form of drawn pictures.

This resulted in a change process driven by and reflected through myths and stories. The work was conducted with the help of group activities as well as individual activities during a continual period. The goal was to achieve an iterative process where storytelling and reflections about myths were related to specific problems, challenges and goals. In the paper we will more thoroughly describe the role of the facilitator who choose the myths and stories that serve as a foundation for a narrative change work. To read and explain a narrative put high demand on the leader who will use it in the organization (Czarniawska, 1998).

4.3 Planning and executing the research

After the researcher had been appointed facilitator for the team, the case was conducted according to the following scheme:

Commissioning the search: Every member of the project team was personally asked if they wanted to participate in the group. They were informed about what the project was trying to achieve, both on a concrete level and about the new method of using myths, stories and tales as an approach. It was seen as very important that the members of the project group were committed to the task.

Identifying the participants: The group consisted of 6 persons from both Guide and the newly bought company Astrakan. 2 people were managers and 4 consultants. The number of meetings where set to 8, each period lasting 3 hours.

Searching a structured change process: The first meeting alerted the change work and its focus on discovering a new creative way to find forms for a pricing model for new services.

First all participants gave their personal and professional view on how they perceived pricing models of IT-services and how the services should be presented to customers. This was a way to create a shared history and letting every participant understand how the world looks according to the other participants.

Secondly the group agreed on a shared view on future pricing models. It was seen as very important to find alternative pricing models to increase profitability in future IT-business. The purpose was to create a shared vision about what is a desirable future or solution to the focal problem of the group.

Thirdly the group had to take part in a number of exercises to find solutions to problems related to pricing models. The purpose was to identify action plans for addressing the focal problem.

Finally the group ran through the solution and gave suggestions for how this new pricing model should be presented internally as well as externally at the customer's site. In doing so, a concrete change activity was initiated to structure a follow-up process aimed at sharing achievements and learning. This exercise integrated five processes described by Greenwood and Levin (1998), namely:

- Create a discourse aimed at sharing different company views, and interpretations of history
- Develop a common vision for the future
- Engage the participants in creative activities, searching for action plans to reach desired goals
- Facilitate a collective prioritizing among action issues

- Link planning to action, action to group and highlight specific actions

The outcome was a set of action issues that participants wanted to pursue collectively.

In the study, the organizational change assignment at hand was combined with exercises that were conducted both at group and individual level, to enhance participants' abilities as storytellers and to increase their understanding of the basic structure of myths. The result is that the change process is driven by, and also perceived as a myth. The myth in question will share the same elementary building blocks as, for instance, a classical Greek myth (Campbell 1973).

5. Results

5.1 The Trojan Horse

The idea of driving change management by narratives within an IT-consultant firm can for a practitioner be seen as unconventional. The present situation of most IT-consultancies is that they are confronted with the balancing of short term aims, as e.g. to keep consultants fully booked, compared to working with business and methods development that could lead to new business opportunities in the future. The IT-consulting market is characterized by strong competition and perpetual attempts from clients to reduce costs. Internal projects are thus rarely prioritized.

The first phase in driving the case was therefore to convince management and other stakeholders about the relevance of the project. Thus, the first matter in question was to make the manager approve the idea of an action research project at the new Organizational development department.

The Organizational development unit consisted partly of old Guide staff and partly of new staff from the incorporated company Astrakan. The manager was persuaded by conveying the facilitator's consultant experience regarding change projects. The idea was then put forward to all the 36 individuals in the Organizational development department at a monthly meeting.

At the meeting the facilitator started with a three minute speech trying to catch the interest of the audience by reciting an abstract of Homers' Odyssey about "The Trojan horse": The intention is to show how an old myth can inspire insights to compel change management processes in today's organizations.

> *"During ten years followed attack on attack and still the Trojan walls stood. Great heroes had fallen in Patrokolos and Hector. Achilles was hit in the heel by Paris. The campaign turned out to be the worst ever for the Greeks."*

The insight you can convey by this is that even in organizations, changes take long time. You have to be persistent to achieve the required goal.

> *"Inspired by Athena, Odysseus came up with an ingenious plan. He had a horse of wood to be built and persuaded some warriors to hide in the belly of the animal."*

During this era it was probably not common that you won wars by hiding in the belly of a horse. Odysseus thus used a different strategy than was usually used. This is also a very important factor in change processes. To let go of old routines, patterns and mind sets, and to achieve new solutions you have to find new creative ideas. You also have to be able to motivate your colleagues making them willing to try new ideas.

> *"The Greek sat the town on fire, looted on all it treasures and killed the inhabitants. The old king Priamos was strangled in front of the family altar. The following morning troy was in ashes and ruins".*

In order to make change permanent something has to die in order for something new to be born. E.g. for an old routine to be substituted by something new you have to disregard some procedures earlier in use.

This myth shows many characteristics of change processes that were similar to those in the organization: change takes time (ten years in the myth); a strong change manager is needed who able to motivate and engage his subordinates; participation and cooperation from everyone is required in order to reach the goal (e.g. Sinom); creativity is required to reach the goal (to build a wooden horse); someone has to die in order to create new points of view (the old king is strangled).

After introducing the research project to the relevant stakeholders successful the facilitator got permission to carry out the experimental change project. The consultants thought the subject was exciting and challenging.

5.2 The experimental change project

A series of eight meetings were set up. The first four occasions dealt with the basics of narratives and exercises how to tell stories and how to write good stories. The first meeting was about deciding which application areas people would like to focus on in the exercises. The group decided to work with marketing and especially the pricing models used by IT-consultant firms.

To find out if the approach was interesting enough to spend so much time on, it was decided to try it for two days and four hour each day. After that an evaluation would be carried out. If the sessions turned out to be successful the project would continue with 8 occasions at 3 hours each. The following two days were spent doing a series of exercises.

Exercise 1 was about listening to the narrative about "The wild boar and the tiger". The purpose here was to get an insight that an organization and its

threats and possibilities can be described and understood based on a narrative written thousands of years ago. By listening to an animal story from India it was possible to see how a social organization function and that problems and challenges found in all organizations regarding power and co-existence can be described and conveyed in an old story. Through the story it become clear that conflicts are timeless and general problems to any organization. The story drew their attention away from the own company by creating a fictive arena that could be used for reflection.

They then had to draw a picture from the narrative about the wild boar and the tiger. By using the picture as a mode of expression, reflections were drawn away from the discursive to the illustrative.

In *exercise 2* the meaning of a metaphor and its significance was discussed. The group drew objects not belonging to a certain environment in order to promote creativity. They also did a visualization of a dream state regarding the Organizational development department in order to create future scenarios: "What does the best setting look like? Who are the participants? What do we have to offer? The participants had to reach a mutual picture and paint it together in small groups.

Exercise 3 introduced something unknown into the familiar. In the exercise either the position or the organization were new to people. They had to describe a scenario of how to sell an existing or a new service to a known or unknown client.

Exercise 4 was a questioning exercise: An exercise regarding the training how to ask the "correct questions" ("How do we market complex services from the Organizational development department to prospective buyers?"). The facilitator wanted the group to try to see sidetracks to the normal procedures, which in general was a very prompt process to find solutions and answers before a correct analysis had been made, not regarding whether the correct questions had been asked or not.

Exercise 5 was an introduction and short information regarding creativity and humor.

Exercise 6 focused on why this new pricing-policy was established. The purpose was to find the nucleus of tomorrow's pricing-patterns and to find out what purposes and needs were behind present pricing-patterns.

Exercise 7 started with a narrative about the crutch and the stick. The facilitator wanted the group to use their fantasy and then tell a made-up story. Each person had written a story during a limited period of time and was asked to tell it to the others.

Exercise 8 was to work with narratives in an exercise where a real scene where brought in, i.e. the setting of a company from the news letter IT West (covers IT-world news of West-Sweden). Here Guide was to sell the service with a new form of pricing. The purpose was by means of a narrative to convey a new pricing model to the client. The group created a scenario in the form of a tale.

Exercise 9 took departure in innovations in nature. Animals should be matched with innovations found in today's society that had the animal world as prototype. The idea was to find new solutions from other environments than the one's where people usually work.

Evaluation of the study was carried out in the form of a personal discussion. The group found that both listening to and expressing narratives, both verbally and in writing, was an enjoyable way to work. They perceived the different exercises as an exiting and challenging way to break old patterns. The project group decided to continue the study with eight more occasions.

6. Discussion

6.1 Creating stories and myths.

While the first four occasions dealt with learning how to tell stories and how to write good stories, the last four occasions dealt with setting up a relevant consultant scenario were narratives could be used to promote change. The scenario was built around a pricing model and a specific client.

The pricing model was decided to be a fixed price to the client. The customer was decided to be the City of Gothenburg to whom Guide was to arrange a service in the form of a role model for the process of developing a new city plan. This process is characterized by many involved actors and delegated decision making on a number of different units in the city administration. The concept was going to be presented to the client in a narrative form.

Guide wanted to offer a client solution in how to work with roles and responsibility in an organization and how to achieve a good communication between different unities in a process. In order to describe the complex of problems Guide wanted to sell its concept in a narrative way as follows. The story is called "Lennart and the peas".

In the group it was discussed in what manner it was possible to use a tale or myth to describe and sell a commission to a client. Suggestions with proposals of different stories from personal experiences were suggested. Group members told stories from Guide that could be good metaphors for this kind of assignment. It was finally decided to use an internal Guide story about a comical situation happening at an Italian restaurant because of uncertainty in the communication between "client" and "supplier". The basic structure of stories and myths that was mentioned in section 3:3 was used for the story.

The story was named "Lennart and the peas" and goes like this:

Predicament: The problems the actors try to solve. In this case it was about to arrange that the food order did not contain food not tolerated by Lennart. *Intentions*: What the actors try to do. Lennart wants to convey to the waiter

a message about his food allergic. *Actions*: What the actors do to achieve their intentions. Lennart gives the waiter a list containing food not tolerated by him. *Objective*: The tools the actors use. The waiter brings the list to the chef in the kitchen. *Causality*: The effects (both the predicted and unpredicted) of realizing the acts. Miscomprehension occurs in the communication between Lennart, the waiter and the chief regarding Lennart´s food allergy. *Context*: The many details surrounding the actors and the acts and description of e.g. colleagues and the restaurant. *Surprises*: Everything unexpected that happens in the story. Lennart is served a dish containing food he does not stand. Lennart almost dies of fright.

6.2 Sharing history

Using narratives created a way of cooperation that is unusual within Guide. By working together with stories, often taken from the organizational life, a sense of shared meaning and shared history was created.

The members of the group used narratives as a way to deal with unknown situations. They learned how to make up, tell and write stories from different perspectives. The group thereby achieved a common language making it easier to communicate using symbols and metaphors describing IT-related occurrences in the organization. By sharing histories, writing histories and telling histories the group created a common history around the project that could be reused and spread in the organizations for others to use.

7. Conclusions

We have experimented with the use of myths, tales, and stories as triggers on group level in workshop situations in order to create a creative and dynamic atmosphere in which change can be achieved. Change projects put a high demand on people's ability to change mindset. It requires motivation and commitment to take on another perspective than the existing one. Change management methods today fails to stimulate people on a deeper level. Talking about the myth and its actors helps people to not be stuck in their old mindsets, linked to the current state of order in the organization. Myths and narratives is a possible way to communicate the values inherent in the narrative to the change project at hand.

Using narratives in group-exercises was new to the studied organization. By using this approach, a completely different way of working was introduced. It did however work well and created a creative climate with many challenging proposals for solutions. One of the goals for the experimental change project was to reach a concrete proposal for price setting. This was achieved in the form of the tale of "Lennart and the peas".

A preliminary evaluation of the group-exercises was done in the form of interviews and observation. The group meant that the exercises were a good

manner to change their mind set. However it requires a lot of engagement, concentration and mental effort to think in narrative forms. It was considered that it requires a long time to train writing organizational tales that both can convey knowledge and insights for the required changes.

As a side effect, one of the participating consultants even tried it out in a customer project outside the experimental research project. He persuaded a group of sales people to make an invitation to a seminar in the form of a narrative. 2500 clients were invited to a seminar prior to a client event. The sales people initially found it unserious and unprofessional, but decided to give it a try and created a story about "William the tailor" that was used for the invitation with great success.

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Involving Distant Users in Packaged Software Development: A User Community Approach

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***Abstract**: Packaged software is an increasingly important form of information technology. However, while user involvement is well established within custom IS development, it is yet to gain momentum in packaged software development. Due to difficulties with (1) distant users, and (2) no coherent use context, packaged software development suffers from less user involvement. In light of this, this paper presents virtual user communities as an alternative approach for involving users also in packaged software development. On the basis of theoretical as well as empirical findings it is illustrated how virtual user communities can be used for solving the difficulties identified above.*

***Keywords**: Packaged software development, user communities, user involvement.*

1. Introduction

Packaged software is an increasingly important form of information technology. In 1998, packaged software had become the fifth largest industry in the U.S. (Sawyer, 2000), and it is now widely used by both business organizations and consumers. In research, the increasing role of packaged software can be seen in the numerous contributions on its implementation. In particular, large-scale and partially modifiable packaged software such as ERP-systems have received much attention (see e.g., Skok and Legge, 2001; Davenport, 2000).

However, while these studies often reflect packaged software implementation, there are interesting issues in relation to packaged software development (PSD). As recognized by Sawyer (2000), PSD will alter how most stakeholders think about software and information systems (IS) development. In highlighting characteristics in terms of (1) industry, (2) software development, (3) cultural

milieu, and (4) teams, it is clear that PSD is significantly different from custom information systems (IS) development. In particular, while user involvement is considered a central belief of custom IS development, it is yet to gain momentum in PSD (Keil and Carmel, 1995; Carmel and Sawyer, 1998; Sawyer, 2000). According to Sawyer (2000), this is due to the fact that users are distant and hence, more difficult to involve in the development process. In addition to this, packaged software is targeted to a mass public entailing that users are not part of any coherent use context. In contrast to custom IS, there are no organizational routines, no coherent work patterns and no overall business goals to relate to when representing users (McDonough et al, 2001).

In light of these difficulties, this paper explores virtual user communities as an approach for involving distant users in the process of packaged software development. Based on an empirical study of a user community associated to a computer game it is suggested that virtual user communities are beneficial both in terms of overcoming distance and in understanding users that are part of different use contexts.

2. Packaged software

Packaged software (also known as shrink-wrapped, commercial off-the-shelf or commercial software) refers to all software sold as tradable products from a vendor, distributor or store, that are designed to be easily installed and to interoperate with existing system components (Abts, 2002) on all computer platforms including mainframes, workstations and microcomputers (Carmel and Sawyer, 1998; Sawyer, 2000). As recognized by Carmel (1997), packaged software came about in the late 1960's as a result of an agreement between IBM and the United States Department of Justice to have IBM unbundle software from hardware. Since then, the market for packaged software has grown to be the US's fifth largest industry (Sawyer, 2000).

Many of the largest packaged software firms are well-known (e.g., Adobe, Microsoft, and Oracle) and examples of packaged software products are operating systems such as Microsoft Windows and Mac OS, desktop publishing software such as Adobe Pagemaker and Quark Express, database programs such as Microsoft SQL and Oracle, and computer games such as Blizzard's Warcraft and Sony's Everquest. However, the largest growth in packaged software is applications (as different from system software) with large packages, of which enterprise resource planning (ERP) software, is the fastest growing segment. This type of software often requires extensive tailoring to meet the specific needs of an organization. This modification is also true for other large business solutions such as SAP and document management software such as DOCS Open and Groupwise.

2.1 Key characteristics of packaged software development

As recognized by Sawyer (2000), there are a number of characteristics that distinguish PSD from custom IS development. Based on empirical results, four distinguishing characteristics in terms of *(1) industry, (2) software development, (3) cultural milieu, and (4) teams are identified.*

First, the packaged software industry is dominated by time pressures. To break new ground in bringing new and innovative products to the market is critical to create return on the investments done by either venture capital or state-supported incubator money. Also, the success of the packaged software industry's products is measured by profit, and to achieve this, there is the challenge of either developing a large installed base or to create new market opportunities.

Second, packaged software development is conducted by developers that often hold line positions which make their needs central to the performance of the organization. Instead of being part of corporate staff and serve supporting role, packaged software developers are production mechanisms and hence, those who generate revenue. In the PSD process there is also a product focus which cannot to the same extent be seen within IS development. Furthermore, the process is immature and there is a distant relationship to the users since users' needs and requirements are most often filtered through intermediaries. This means that user participation methods, as well as formalized software development methods, are not used to any great extent. Rather, the development process is highly iterative, flexible and constantly evolving and while there are indeed attempts to involve users, these are often restricted to beta testing or demonstrations.

Third, the *cultural milieu*, in terms of ideas, values and shared norms, of PSD is entrepreneurially-oriented and individualistic.

Finally, PSD *teams* are typically small, co-located and remain committed to a product over several versions or releases. Consequently, they often work together for long periods of time and define goals over prolonged periods. Also, motivation is often manifested in financial rewards such as stock options and bonuses that can provide a lucrative bonus for developers in PSD firms.

2.2 Key difficulties in packaged software development

Of critical concern to any software development process is the understanding of user needs and requirements. In IS, this is reflected in a number of studies on user participation (Barki and Hartwick, 1994; McKeen et al, 1994; Tait and Vessey, 1988; Barki, 1989; Butler and Fitzgerlad, 1997) and user participation methods (see e.g. Avison and Fitzgerald, 1995; Checkland, 1981; Mumford, 1995). However, while these studies reflect on user participation, and methods to support this, in traditional IS development, there is little research on user

participation, and how this can be achieved, in PSD. As identified in research, there are specific difficulties associated with involving users in packaged software development. These difficulties are outlined below.

First, as identified by Sawyer (2000), users are *distant*. Looking at successful packaged software products, such as Microsoft Windows, Adobe Pagemaker or games such as Warcraft and Everquest, users can be found all around the world. As thrilling as this might seem, this fact makes it difficult to use conventional techniques for user participation as advocated by, for example, participatory design (Greenbaum and Kyng, 1991; Namioka and Shuler, 1993) or contextual design (Beyer and Holtzblatt, 1997). While these techniques succeed in capturing both individual expectations and organizational needs, activities such as user workshops, role playing and mock-ups are typically location-dependent activities and hence, do not resonate well in the distributed environment of PSD. Here, commonly used techniques are instead support lines, surveys, user groups, trade shows, marketing and sales (Keil and Carmel, 1995). However, while these techniques make possible for user-developer interaction also in distributed settings, the contact is often mediated through intermediaries or customer surrogates (Keil and Carmel, 1995) and hence, difficult to rely too heavily on. Furthermore, while recent research suggests groupware systems for interacting with users (Tuikka and Salmela, 1998; Fukushima and Martin, 1998) these systems are difficult to apply in PSD where the products are intended for a mass public of which representative users are difficult and sometimes impossible to identify in advance (Keil and Carmel, 1995).

Second, PSD users are not part of a coherent *use context*. In contrast to custom IS development conducted within organizations, PSD is targeted to a mass public. As well as organizations are characterized according to the work routines that are carried out, organizational members can be characterized according to the context of which they are part. Hence, custom IS development benefits from the fact that users are part of the same organizational context. In PSD, on the other hand, there is no coherent use context, and there exists little data material for characterizing users. In contrast to custom IS development there are no formal work patterns, no organizational processes and no organizational goals available to facilitate the process of understanding users. Consequently, users cannot be represented in terms of profession and professional domain, and the overall context in which the software is to operate – and the purpose for which it is used - might not be shared but instead different for every single user. As recognized by McDonough et al. (2001), the process of understanding user needs and requirements is no longer a matter of identifying needs of a relatively homogenous group, as for example of users within an organization. Instead, it requires an understanding of globally distributed users who are located in different countries, who speak different languages, who have different cultural beliefs and who may not be able to ever meet physically with each other or with the software developers. While, for example, scenario-building and rich pictures (Checkland, 1981) aim at capturing the complex

relationships within an organization, PSD cannot benefit from a shared use context, and the developers can in most cases only guess what types of users that will use the products (Divitini et al. 2000).

To address these difficulties, this paper explores virtual user communities as an approach for involving users in the process of PSD. In a user community, geographically distributed users can interact with each other as well as with the developers, and there are reasons to believe that this interaction can facilitate the difficulties experienced with regard to user participation in PSD.

3. User communities

Recently, open source software (OSS) development communities have attracted much attention. In these communities, geographically distributed users meet to share information and collectively develop software applications, predominantly operating systems and web application systems (Feller and Fitzgerald, 2002). Membership in these communities is voluntarily and, instead of monetary benefits, contribution is based on motivation (Ye and Kishida, 2003). What the community provides is a platform for collaboration and exchange of information.

As recognized by Ye and Kishida (2003) there are abundant lessons to be learned from OSS development. Several case studies highlight the particularities and the fascination of open source (Mockus et al, 2002; Moon and Sproull, 2000) and for example, motivational factors (Ye and Kishida, 2003), trust issues (Gallivan, 2001), and the many pros and cons of OSS development (Jørgensen, 2001; Sharma et al, 2001) have been studied in order to see to what extent the open source paradigm can be transferred to traditional organizing and traditional software development.

In this paper, user communities and the impact of these in terms of user participation in PSD is explored. Besides the many suggestions of how to learn from OSS development as put forward in the research mentioned above, there is little doubt that the benefit of having user communities participating in the development process has attracted many traditional software development companies. Countless are the examples user communities associated to different software products, and while these communities do not offer the opportunity for users to modify products in terms of getting access to the source code, they constitute an important forum for discussion and exchange of ideas between users and developers of particular software products. Below, the concept of 'community' is elaborated upon and the phenomenon of user communities is further exemplified.

3.1 Community – what is it all about?

The concept of community is by no means a new phenomenon and stretches well beyond the studies conducted within the field of IS. In a survey conducted already in 1955, Hillery subjected 94 sociological definitions of the term 'community' to analysis in order to identify defining concepts within that sample (Hillery, 1955, p. 111). As a result, he found one concept – *people* – that was evident in all 94 definitions, and three additional concepts – *social interaction, common ties and shared area* – that were evident in a majority, i.e., in 69 of the definitions.

More recently, the need for a definition of community has become evident also outside the sociological field, and ever since the association of the term with computer-mediated interaction, i.e., 'virtual community' or 'online community', IS researchers have been struggling with the definition as well. Here, labels such as social networks (Andrews, 2002), learning networks (Hiltz and Turoff, 2002), communication networks (Monge and Contractor, 2000), and online social structures (Butler, 2001) are used to describe the phenomenon of people interacting in computer-mediated environments. Often, community members are described as having a common discourse and communicative style (Baym, 1998) from which identity and meaning emerge (Donath, 1999).

In prominent definitions presented by Rheingold (1994, p. 5) and Whittaker et al (1997, p. 137), 'personal relationship', 'companionship', 'shared goal' and 'shared context' are identified as core attributes of a community.

Another well-known definition is the one presented by Preece (2000, p. 10). In this, 'people', 'purpose', 'policies' and 'computer systems' are introduced as high-level criteria for defining a virtual community. Focusing more on the technical aspects, Stanoevska-Slabeva and Schmid (2001) introduce 'technological mediation', 'ubiquity' and 'online identity' as distinguishing features imposed on a community by the usage of the digital medium. Similarly, research on system architecture and system topology describes virtual communities in terms of both the members and the platform, and it is suggested that the technical aspects are significant for the overall community building process (Hummel and Lechner, 2001; Stanoevska-Slabeva and Schmid, 2001).

Although articulated differently, the definitions mentioned above share many similarities. Below, Wenger's (1998) notion of 'communities of practice' is used as a framework for understanding what represents a community. In defining communities in terms of 'joint enterprise', 'mutual engagement' and 'shared repertoires', the notion is useful for capturing the essential features inherent in a community.

As can be seen in the community definitions above, they all describe people who engage socially with shared goals or interests as primary reasons for interaction. In this interaction, we form a collective understanding of the

world and of what we do, we create personal identities in the context of which we are part and we engage in activities in which we share historical and social resources with other people. According to Wenger (1998) this interaction can be understood in terms of 'joint enterprise', described as the collectively developed understanding between community members of what their community is all about.

Also, the many definitions describe the interaction between community members as mutual. While Preece (2000) emphazises information exchange between community members, Whittaker et al (1997) as well as Smith and Kollock (1999) discuss the importance of reciprocity of information. In Wenger (1998), this reciprocity is understood as 'mutual engagement', reflecting the interactions between people, the actions that they are involved in and their negotiated understanding of what these actions are all about. Furthermore, mutual engagement is what defines belonging, and the ways in which we engage with each other and with the world is what shape our understanding and our experience of whom we are (Wenger, 2000).

Finally, many definitions deal with community members as having shared policies (Preece, 2000) and shared resources (Whittaker et al, 1997) in terms of rituals, protocols and rules, as well as language, discourse and communicative style (Baym, 1998). In Wenger (1998), this is depicted in terms of 'shared repertoires', referring to the resources for negotiation of meaning, including routines, words, tools, ways of doing things, stories, gestures, symbols genres, actions and concepts (Wenger, 1998) as well as language, sensibilities, artifacts and styles (Wenger, 2000) that the community has produced or adopted in the course of its existence. For example, the repertoire includes the discussion by which members create statements about the world, as well as the styles by which they express their forms of membership and identity.

In summary, the concept of community can be understood in terms of the three basic elements presented by Wenger (1998). In bringing together many of the concepts found in the above mentioned definitions, the framework of communities of practice very well embraces what is important in a community. For the PSD process, communities constitute interesting structures that provide benefits by supporting interpersonal relationships and companionship, encouraging discussion and knowledge sharing, allowing for quick access to information and enabling collective action such as, for example, software development (Butler, 2001).

3.2 User communities – for whom and for what?

User communities, or user groups, have become a dominant feature in association to software product websites on the Internet. Today, the creation of user communities has captured popular, as well as scholarly, attention and the phenomenon is championed by computer scientists as well as CEO's. Not surprisingly, new business opportunities has emerged and already there are

several companies offering software solutions for creating user communities in which people can collaborate and exchange ideas independent of location and time. For example, there is Web Crossing (www.webcrossing.com) and Ramins (www.ramins.net) which provide companies such as for example NetSuite and Nortel Networks with software so that they can benefit from having users meet virtually to discuss their products. As it seems, these companies believe that there is important information inherent in their user communities that, if supported, can provide valuable input to the company and the development process of different products.

As acknowledged by IBM, their user groups provide *"...an open forum for easy exchange of information as well as valuable information to IBM development and support"* (www-306.ibm.com). In reading this statement, much of the essence of software user communities is captured as well as the context within which they often appear. As can be seen in the IBM example, easy exchange of information is regarded the driving force in a user community and the members enjoy the opportunity of having access to other peoples' experiences of one particular product. Many times, a user community can be seen as a "problem solver" in that the users benefit from helping each other and due to the mutual engagement (Wenger, 1998) of a community, information exchange and retrival is smooth and fast.

Regarding the context, software user communities appear in association to development and support of particular software products or software development platforms. For example, there are the CATIA user communities (www.tenlinks.com) discussing CAD/CAM products, the IBM Tivoli user communities (www-306.ibm.com) discussing this particular software for intellectual capital management and access. In association to development tools and platforms, there are the Java Technology user communities (http://developer.sun.com) in which more than 500 groups in 100 countries discuss Java technology and Sun products and there is the GapiDraw community (www.gapidraw.com, www.pocketmatrix.com) in which GapiDraw - a graphics platform for creating applications on handheld computers and Smartphones – is discussed by its international community of users.

3.3 User communities in packaged software development

As indicated in the beginning of this section, user communities are not only for users but also for developers of software. As recognized in the IBM statement, user communities can provide valuable information for developers in the development and support of different software products. By taking part in community discussions, software developers can learn about specific installation and configuration problems, pin-point bugs and errors as well as elicit user suggestions for future modification and functionality addition.

This is particularly valuable in PSD. As recognized earlier in this paper, there are two difficulties associated with PSD. First, users are *distant*. Second, users are

not part of any coherent *use context*. For the software development process this entails problems in terms of user participation. While conventional methods for user participation offer various techniques for involving users – these are often difficult to apply in relation to distant users. In addition, the fact that the users are not part of any coherent use context adheres to the difficulty of representing users in PSD.

However, while conventional methods might be difficult to apply, there is always the opportunity to look for alternative approaches to solve the difficulties associated with user participation in PSD. Based on an empirical study of a computer game community, this paper explores how virtual user communities can be used as one approach for facilitating the difficulties as mentioned above. Below, the research setting for this study is outlined as well as the research method that was deployed.

4. Empirical setting

4.1 Daydream Software

Daydream Software is a Swedish computer game developer with its foundations in Sombrero AB, a company focusing on software systems and hardware sales. During the period of this study, January 2000 – October 2002, the company consisted of employees ranging from managers, administrative personnel and marketing people to game developers, graphical designers and web designers. With successful products such as 'Safecracker' and 'Traitors Gate', Daydream had a large international customer base and well established user communities. In this study, the focus was on the development of Clusterball – a computer game sold as packaged software to computer gamers all around the world. In relation to this game the Clusterball community (to be found at clusterball.com) soon arose and today the community embraces of the product as well as the developers themselves.

4.2 The Clusterball community

4.2.1 A group of people

The Clusterball community is a game community consisting of members mostly from northern Europe and the US. Depending upon previous game scores, each member is categorized according to the official Clusterball ranking, ranging from 'newbie', 'ballboy' and 'trainee' to 'master', 'grand master' and 'cluster king'. In total, there are 20 different ranking categories and members with the highest rankings are well-known and celebrated members in the community. Together, they engage in discussions concerning Clusterball, and on a regular

basis they arrange tournaments and team-play as well as tutorials and training sessions for Clusterball beginners.

Also, many of the developers at Daydream are active community members. Not surprisingly, the Daydream developers can be found in the upper categories on the ranking list since their profound knowledge about Clusterball makes them skilled gamers.

4.2.2 Shared social interaction

With approximately 17,000 postings distributed among two different forum tracks over a three-year period, the Clusterball community provides an active discussion forum for the development and the modification of the game. As recognized by Baym (1998), the communicative style of participants in such communities are often oriented around common interests and practices even before they enter the computer-mediated world, and often members adhere to certain norms of rational discourse. In this case, the technology becomes an enabler of already established physical communities – a description that is apt in describing the Clusterball community.

However, clusterball.com is not the only place where the Clusterball community meets. Besides this forum, there are 6 fan websites (websites developed by community members themselves) that offer forums and chat rooms for community members, and 28 team websites where different teams meet and sign up for tournaments. One of the most impressive fan websites is Ballsnatchers.com which was originally developed exclusively for Clusterball by two of the gamers, and which is now maintained and further developed by a team of Clusterball gamers from all over the world. Here, the gamers have their own 'hall of fame' (player/team victory announcements), a 'haiku corner' (player poems) and a 'player gallery' (player portraits).

4.2.3 Common ties

The common interest in the Clusterball community is computer games in general, and Clusterball in particular. In the different forums, community members discuss configuration and installation problems as well as tournaments, team-play and how to improve the game. At Clusterball.com there is the 'technical' and the 'general' forum, and at Ballsnatchers.com there is a specific forum for beginners called 'young wings' where new gamers can post any questions they might have to the rest of the community. Also, there is a 'chat-and-gossip' forum in which the gamers discuss anything that comes to mind.

The devotion and motivation among community members can also be seen in the activities they organize. For example, there are several "Clusterball Schools" for beginners (see for example Ootpek's Clusterschool, Kronix Tips and Lava-Lava's Clusterball Tips at www.clusterball.com), a 'Skin Tutorial' in relation to a skin site on which gamers upload their individually designed

skins so that other gamers can download and use them, and a testimonial site where Clusterball gamers share experiences from their initial contact with Clusterball.

4.2.4 Shared area

To communicate, the Clusterball community members send postings to electronic fora consisting of several different tracks. In these, headings are shown for all topics, and all postings are presented as threaded lists. Also, there is a chat so that people can meet before the game, as well as after, to discuss issues concerning that particular gaming session. In addition to this there are the fan websites where several other fora and chats can be found and where many of the Clusterball gamers spend time on a regular basis.

5. Research method

The research outlined in this paper is part of an interpretative case study (Walsham, 1995) conducted at Daydream Software between January 2000 and October 2002. In this longitudinal field study, consisting of an *exploratory study*, in which we sought an initial understanding of the company, an *in-depth study* involving participant observation at the research site, a *complementary data collection* phase in which interviews and surveys were carried out and a *follow-up study* consisting of additional clarification interviews, we sought to understand the particular context of Daydream Software and the way in which a virtual user community was used for user-developer interaction in the development process of a packaged software product.

In this particular paper, our objective was to investigate how user communities can be used for involving users in the PSD process. To do this, user community *postings* to the technical forum at 'clusterball.com' were analyzed with regard to discussion theme and result in terms of modifications to the software. Postings included those sent to the forum between the release date July 17, 2000 and May 2001, when the complementary data collection phase was finished. During this period, 1,116 messages were posted to the technical forum. In reading the postings, special concern was taken to those reflecting user needs and requirements and whether these were responded to by the developers.

Below, a selection of these postings is used to illustrate the way in which the user community allowed for distant users to be involved in the development process of Clusterball.

6. Distant Users in the PSD Process

6.1 User bug reports

As soon as Clusterball was released on July 17, 2000, the global community of users were involved in the process of correcting errors and locating bugs. Primarily, the user community helped in identifying installation and configuration errors, something that is reflected in the postings below:

> *"A few times now I've had the game just hang. It's always right after a game when it says 'time limit reached' or on the loading screen before a game starts. It will just stay at those screens forever and nothing will happen. I was curious if this was related to Win2K or something else. Machine is P2-450, 348 ram, Voodoo3 3000, Win2K Pro. I've installed the host error patch as well though this happens when I'm joining a game not hosting".*

> *"Right when the loading screen appears I get an illegal operation and I have to close it. This happens every single time. I have a diamond ViperV550, running 1280x1024 32bit, and win 98. I have had some problems with other games not switching to direct 3d mode but nothing like this. Please help, I'm very annoyed".*

Furthermore, different crash bugs were identified and the user community successfully helped the developers at Daydream in understanding individual configurations and the different situations in which these caused the game to crash. Among many others, the following postings were sent to the community:

> *"Hi, My crashes end with: CLUSTERBALL caused an invalid page fault in module CLUSTERBALL.EXE at 015f:0054e7e4. It crashed mid-game. I have a 450 Athlon, 256mb, GeeForce256. Any suggestions? Thanks".*

> *"When there are too many 'activities' going on in the pre-game chat room, Clusterball has a tendency to crash. I didn't note the error message though".*

As a response from the developers, these errors were handled in the first and second patch that were released on July 18 and August 25 respectively, very soon after the official launch of the game. In these patches most installation and start-up problems were solved, and it was clear that the users had a significant influence on the initial configuration of Clusterball.

6.2 User adaptation suggestions

Besides correcting errors and locating bugs, the user community was frequently used to understand what environmental changes, such as other software and

hardware requirements, that could have an impact on the game. A common theme across these postings was the desire for adaptation of the software to other operating environments or to be able to play the game using other configurations. This is reflected in the following postings:

> *"I wish the standard 'control setting' was better. At present, getting a good control setting is too much a case of trial and error. But if people have problems with this they don't play".*
>
> *"It would be better if there was support for more video cards…".*
>
> *"I've just bought the Saitek Cyborg 3D Joystick which has solved the jerky controls of my previous low budget version. The problem is the throttle doesn't seem to give full speed and the response to change direction etc is very slow. I use standard PRO settings. The joystick seems to be calibrated and profiled correctly but I can't get round these problems. Any ideas anyone?".*
>
> *"I got an ATI Rage 128 graphics card. I'm not sure what you mean about the "environment map". But when I play Clusterball, all the ships and balls are black. I need some help. I can still play but it is very annoying. Well thanks for the help".*

While some of these suggestions were not put attention to in an immediate way, an A2D Driver patch was installed to solve the graphics cards problem as recognized by one of the users. Furthermore, an additional GL Setup patch was released on February 22, 2001. This patch detected what kind of graphic card the user had and consequently downloaded and installed the latest drivers for that particular card. While these patches might be regarded as small steps in terms of adaptation, they still show that the user community had an impact on small changes of the game.

6.3 User functionality suggestions

In the process of future improvement, the user community was continuously used for elicitation of innovative ideas. Consider these postings, all suggesting additional functionality:

> *"I think you should integrate an IRC client into the software so that you could access the Clusterball channel from inside the client".*
>
> *"I would like to see tournaments for middle class rankings. There are tournaments for new people and for high class players, but the middle men are left out".*
>
> *"I would like to improve the match making – to allow the possibility to find other players closer to my skill level".*
>
> *"I would like to be able to set a minimum and maximum player ranking when I host a game. In this way, a Newbie game will really be for Newbies, experts won't come along and thrash everyone. Similarly, a*

group of experts won't have to worry about a raw "what do I do with these balls?" beginner unbalancing team play".

Also, the need for elaborate chat features was expressed by some of the users:

"It would be great to have a chance to chat with the experts. The 'Ring Kings' could participate and give the 'Newbies' some hints live".

"I would like to have the possibility to talk to other players while waiting for a game".

"There needs to be a better chat function in the game. The one that is there in this version is really bad – nobody sees it".

To some extent, these suggestions were taken into consideration in the following patches. For example, the wish for better match-making were implemented in the third patch, released on October 19. In this, the ability to lock a server on a minimal/maximal ranking basis was implemented, and hence, unbalanced match-making could be avoided. Also, and in response to the wish for a better chat, the third patch included a pre-game chat. Using this, gamers could talk to each other while waiting to join a game and they could exchange experiences from games they had participated in. In addition, longer chat-lines in the in-game chat were implemented to improve the overall chat function.

While many suggestions were implemented in the different patches there were also suggestions that were never put attention to by the developers. Consider the following postings, all reflecting user suggestions that were never implemented during the period of this study:

"Make more then just the ship playable, most other games have more than one model to choose from. It doesn't have to be that different, but still another model to choose from. Maybe there could be a model editor where players could make their own ships…".

"Could there be a 'viewer system' so that my friends could watch other people play before they participate themselves? The game would be more like a real sport if it was viewable on TV or the Internet".

"Make the venues change weather sometimes. The sun isn't always shining. Perhaps a change in wind could make the venue Egypt more difficult".

Despite the fact that these suggestions were never implemented, they were still seen as important for both Daydream and the user community. Besides concrete suggestions on future functionality they reveal an engagement and an interest that can otherwise be hard to capture within a distributed user group.

6.4 User-developer-user triangulation

For problem solving, the user community was often used for detailed triangulations between users and developers. In particular, this could be seen when trying to identify complex problems or discussing components that were shared by many users. Consider these postings in which both users and developers were engaged in discussing sound – and graphic card problems:

> *"I like the new patch, but damn, I can't read anything when joining the chat. I have a 19" monitor but I still can't read that crappy font. Also the sound is still a problem in XP with SB Live sound card".*

This posting got a quick response from one of the developers at Daydream:

> *"… the soundcard thing is out of our reach, let's just hope that Creative will update their crap drivers for XP soon. I've got this sound volume problem with lots of other games in XP as well...see what I can do".*

Furthermore, a discussion was initiated by one of the users experiencing a problem with the graphics card:

> *"I got an ATI Rage 128 graphics card. I'm not sure what you mean about the "environment map". But when I play Clusterball, all the ships and balls are black. I need some help. I can still play but it is very annoying. Well thanks for the help".*

In responding to this question, one of the Daydream developers attempted to further elaborate the nature of the problem:

> *"I have actually seen this "black ball" phenomenon happen during development. I think it was with very old drivers on a Riva TNT card. Since you want FULL support I'll just start asking my (huge) line of questions:*
>
> *1. Have you installed the latest OpenGL drivers for your ATI Rage 128?*
>
> *2. Could you check in the Control Panel-> Display->Adapter that OpenGL is chosen the DEFAULT renderer (important!)*
>
> *2.2 Also, while in the Display settings, what level of 3D acceleration is set, FULL, 75%, 50%, 25%, or what ?*
>
> *3. There is a possibility that the game tries to run software renderer instead of OpenGL... is your graphics "grainy" like software rendering?*
>
> *4. Do you have DirectX 7.0 installed?*
>
> *5. What is your computer name, processor speed, etc?*
>
> *6. If you open the config.cfg file in Wordpad, what value does it say after renderer?".*

Other community members, using other graphics cards, were also involved in the discussion:

> *"Dear Clusterball Support: Is CD supposed to work with the Voodoo5 FSAA? Whenever I have it enabled, starting a match freezes my system 80% of the time online, and about 20% when offline training. FSAA works 100% fine on ALL of my other games, online and offline".*
>
> *"Clusterball is not working so well with the new driver from NVIDIA. I'm using a TNT Ultra 2 and have tested the new drivers. I installed it and I'm using the old one from January 2000".*

In this type of triangulations several users were involved for identifying and solving problems. For the process of PSD, there are reasons to believe that this was beneficial to the overall involvement of distant users, as well as for the understanding of their different needs and requirements.

7. Discussion

Based on the empirical illustrations from the Clusterball community, this paper explores virtual user communities as an approach for involving distant users in the process of PSD. Despite geographically distributed, this study shows how the Clusterball users were continuously involved in bug reporting, in software adaptation and in suggesting new functionality. In these activities, the community provided a platform for smooth information exchange and retrieval but also for relationships to be formed, for social interaction to take place and for ties to be established (Rheingold, 1994; Preece, 2000; Whittaker et al., 1997; Wenger, 1998). Hence, the community allowed for *contact* between geographically distant users and developers.

Furthermore, the study illustrates how user-developer triangulation was successful in locating specific errors and how the community in particular made possible for this type of trouble-shooting. As an open-forum model in which aggregations of people (Rheingold, 1994) engage in repeated interaction due to a strong shared interest (Preece, 2000; Whittaker et al., 1997), there was the possibility for users and developers to effectively elaborate on certain problems, and also, to benefit from the fact that several users could be involved in solving a problem at the same time. As a result of such processes there was not only the possibility to solve software problems. Also, the dialogue made possible for the developers to create an *understanding* about individual users and the different contexts within which they used the game.

However, while this might suggest that distant users were involved in all PSD activities, this was not the case. As recognized in the study, user bug reports concerning for example installation and configuration errors were quickly taken into consideration by the developers at Daydream, and the impact of these could also be found in the patches that were released. However, there were many suggestions that were never put attention to. For example, suggestions

concerning new functionality and major changes were seldom acknowledged although they were frequently occuring in the community. Without ever being responded to, suggestions regarding a veiwer system, playable ships and changing weather in the different venues were posted and there are reasons to believe that the developers would like ideas requiring major re-design come from the developer community itself. Interestingly, a similar phenomenon was reported in the Mockus et al (2002) case study of the open source Apache web server which found that 75 percent of user suggestions for modifications are ignored. This is quite common in open source projects, and it has been suggested that a meritocracy exists whereby the privileged few at the core control almost exclusively the ongoing development of the projects. In this, there seem to be parallels in the Clusterball case, although it is not an open source project in any sense. However, while many suggestions were never put attention to during the time for this study, they can still be seen as important to Daydream for other reasons. In revealing interesting ideas they also reflected the interest of individual gamers in the community. This would suggest that the user community, besides working as a quick input for bug reporting and error location, also had potential in the more complex process of creating an understanding of the users - a process that is particularly difficult in PSD where the products are sold to a mass-market and where the users are difficult to represent.

8. Conclusion

In contrast to custom IS development, user involvement is yet to gain momentum in PSD (Sawyer, 2000). Due to difficulties with (1) distant users, and (2) no coherent use context, traditional user participation techniques are hard to apply. In overcoming these difficulties, this paper explores virtual user communities as an approach to acheive user involvement also in PSD.

Based on an empirical study, as well as a theoretical understanding of communities in which relationship, social interaction and emotional ties are considered inherent features of communities (see for example Rheingold, 1994; Preece, 2000; Whittaker et al., 1997; Wenger, 1998), we believe that virtual user communities allow for *contact* between geographically distributed people – something that facilitates the difficulty associated with distant users. In the empirical case, this was reflected in activities such as user bug reports, user adaptation suggestions and user functionality suggestions. In these activities, distant users were frequently involved in the development process and there are reasons to believe that the community made possible for significant user impact despite their geographical distance to the developers.

Secondly, as aggregations of people (Rheingold, 1994) that engage in repeated interaction due to strong shared interests (Preece, 2000; Whittaker et al., 1997), virtual user communities allow for an *understanding* of other people and their various contexts – something that facilitates the difficulty associated

with understanding users that are not part of any coherent use context. In the empirical case, this was reflected in the triangulations that took place between users and developers. In these, problems were elaborated upon and there was the possibility for the developers to learn about individual users and their different problems and their particular use contexts.

Finally, there are of course limitations to this study that should be acknowledged. Undoubtedly, not all communities are like the game community presented here, and not all software has features similar to those in a computer game. As a result, the extraordinary motivation level of gamers may not be found in other communities and in relation to other software products. However, in illustrating the use of virtual user communities for leveraging user involvement in PSD, the Clusterball case constitutes an interesting example from which there is still the possibility to gain both inspiration and insights on community behaviour and community prerequisites.

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Investigating Mobile Services' Adoption and Diffusion in the Danish Market

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***Abstract**: This paper investigates mobile services adoption, diffusion and usage patterns in the Danish market. A similar empirical research was conducted during 2001 in Finland, Germany and Greece when mobile services were first introduced. This paper explores the impact of a set of attributes identified on that research in a more mature market context and underlines the importance of mobile devices' functionalities in the evolution of mobile services market. Our objective is to confirm or reject and possibly expand the attributes that affect consumer behaviour in the long run, highlight the differences due to market evolution and observe the specific socio-economic characteristics of Danish market. We use an online survey that is based on the earlier research, but has been elaborated to address specific Danish market characteristics (e.g. the recent introduction of 3G services). The results indicate the evolution path of mobile services' market and highlight the fact that the adoption of mobile services is accelerating.*

***Keywords**: mobile services, adoption, diffusion, consumer behaviour.*

1. Introduction

New mobile services are launched at a rapid pace in most countries around the world. However, companies involved on the content provision have learned that technological advances and service availability do not automatically lead to widespread adoption and use. For example mobile banking services have been available for almost half a decade. Yet, mobile users have not embraced them, as PC-based Internet banking that is now widely adopted. Moreover,

information services similar to the ones available on the Internet are not widely used even if they have been available since the deployment of WAP technologies.

Most of the traditional diffusion of innovation literature (Rogers, 1995) would argue that the greatest benefits from a service belong to the first adopters and while the adoption proceeds the relative advantage of being an early adopter diminishes. Furthermore, traditional diffusion of innovation literature argues that latter argument is prominent in case of a company, which cannot sustain a competitive advantage based on a single technology, since others will imitate it and consequently achieve a similar advantage. We argue that for mobile services the same logic cannot be readily applied. The greatest benefits from mobile services often come after their widespread adoption. For instance, in case of SMS, its value increases as the number of adopters increases due to network externalities. Most services become more readily available and better developed as the customer base increases. We have some indications from earlier studies of mobile services on the main attributes pertaining to adoption and diffusion. In this study we seek to confirm, reject and expand these factors by building a survey that incorporates earlier findings with current knowledge and local characteristics. In particular, we provide insight on the following question:

- What factors explain users' adoption and diffusion of mobile services?

The adoption of mobile services is not random. We believe that there is a certain order in which services are adopted and appropriated. Thus, the adoption trajectory forms a path that evolves under the influence of specific factors. By investigating the key factors affecting adoption, diffusion and usage of mobile services it is possible to identify behavioural patterns pertaining to the specific market. These patterns may offer insight in the strategic planning of key players and consequently enable them to generate revenue and strengthen their market position. As of now, the low adoption and use of WAP enabled services underline the need to be cautious in case of GPRS/EDGE and 3G enabled services. While the recent trends of GPRS enabled services' adoption are ambiguous, we witness that the use of some independent services (e.g. MMS) is increasing rapidly. On the contrary, transactional services, have not yet reached a critical mass of users.

This paper is organized as follows. Section 2 offers a brief review on related theoretical work to consumer behaviour of electronic and mobile business and highlights the results of a previous survey with similar objectives as well as the market trends of Danish mobile communications market. Section 3 presents the research methodology used, the demographic characteristics of the sample and the hypothesis tested. Section 4 presents part of the preliminary results and addresses the research question set. Finally, section 5 concludes by underlining the main results and highlighting future research directions.

2. Consumers' reactions to innovative mobileservices

2.1 Research in consumer behaviour of electronic and mobile business

Reviewing the business to consumer (B2C) e-commerce literature, it is clear that the majority of research efforts have focused on the Internet, rather on mobile telephony. As noted by Anckar & D'Incau, our understanding of the real value-adding elements in mobile business is limited, in particular "the consumers' actual reasons – the primary drivers – for adopting and intending to adopt mobile services remain unclear" (Anckar & D'Incau, 2002). However, mobile business dynamics generate challenging research questions that enable building new theoretical frameworks as well as investigate managerial implications and emerging business opportunities.

Besides, B2C electronic commerce, independent of the access device (e.g. PC, or mobile phone), has for any product, or service offering one generic but crucial objective: to satisfy consumers, create value and build strong relationships (Grönroos, 1997; Ravald & Grönroos, 1996) that are characterized by high level of loyalty, return patronage and bi-directional enthusiasm. In pursuit of in depth understanding, investigating consumer needs, wishes, preferences, attitudes, characteristics, and behaviours related to current and anticipated mobile phone use becomes invigorating for strategizing, development efforts and marketing. It is the authors' position that users' survey is a reliable and applicable method when the research purpose is to generate market data for comparison among broader categories of a population. Moreover, careful generation, dissemination and responsiveness of and to adequate survey data, can also guide organizations towards increased market orientation which in turn is connected to higher levels of organizational performance (Jaworski, Kohli, & Sahay, 2000; Jaworski & Kohli, 1993; Slater & Narver, 2000) and innovation (Baker & Sinkula, 2002; Han, Kim, & Srivastava, 2002; Hurley & Hult, 1998). Thus, in the realm of investigating consumers' current and future needs, existing customers are a constituent group of significant importance in providing guidelines for the development of marketing and innovation strategies.

Online markets (either accessible through the PC, mobile phones or other wireless devices) constitute a channel for exchange which requires fundamental alterations in the purchasing behaviour among customers. Therefore, a key task for e- and m-business is to find out who the actual and potential customers are (Turban et al. 1999). Along the same lines, Petrison et al. (1997) support that thorough knowledge of consumer behaviour, coupled with advances in technology, enable marketers to target customers on a more personalised, customised and segmented basis. However, consumer

behaviour towards mobile services has not yet been the subject of much research (Anckar et al., 2002; Pedersen, Methlie, & Thorbjørnsen, 2002) in Europe. Moreover, "in today's marketspace the consumer is gaining more power as new distribution systems are driving price down, making access to both products and the information needed to compare alternatives easier" (Scultz and Baily 2000, p.50). Regarding this observation, Cole and O'Keefe (2000) and Vrechopoulos et al. (2000), state that consumer behaviour research is moving beyond the simple application of traditional consumer behaviour models towards a generation of new models, which are more relevant to the online environment.

The present study aims to contribute in the understanding of consumer behaviour in case of mobile services. To accomplish this aim we offer insight on consumer attitudes and behaviours towards mobile services based on the preliminary results of a survey.

2.2 The results of the previous survey

During 2001 a similar study was conducted in Finland, Germany and Greece (Vrehopoulos et.al. 2002, 2003) in order to record and compare the attitudes and perceptions of Internet and mobile telephony users on new technology and services in mobile business (such as WAP, GPRS, purchases via mobile, etc). The study was based on an online survey that was addressed to a self-selected sample of Internet users. According to this survey findings, the cost of service, the usability of the device and the value of content were highlighted as key determinants of mobile services adoption and use in the three countries under investigation.

With respect to mobile services' use, besides the "killer-application" SMS, very few others were reported to be used at a significant level. Among these services were information services (e.g. brokers) and mobile banking. Mobile services were mainly adopted due to their always and anywhere availability and the increased comfort they provided. New mobile services were diffused through social networks mainly by friends and colleagues. The Internet also played an important role as an information channel in the diffusion process. The latter finding is also supported by earlier research indicating that virtual communities might play a vital role in catalyzing mobile service use (Rheingold, 2003), (Kim, 2000).

The main deterrent for adoption of new services was reported to be the perceived high access price. At this point is important to remind the reader that during 2001, mobile services were mainly supported by GSM networks and circuit switched network services. Thus, the total price paid by the user included the network service (i.e. the connection time to the WAP gateway) as well as the mobile service. However, the survey results also indicated that mobile users were able to differentiate between the connection fees and the charges for the actual mobile services. While the former were perceived as

rather high, the latter were perceived as relatively low priced. Moreover, factors like inconveniences of present devices and shortcomings of mobile services also were regarded as obstacles for the acceptance of mobile services in the three countries under investigation. In particular, the key factors affecting mobile services' market evolution according to the survey were:

- Ease of Use Interface
- Security
- Customer Service
- Price
- Personalisation
- Comfort of Device

2.3 The Danish market

The Danish mobile communications' market has been chosen for the purpose of this research due to its considerable maturity compared to the markets investigated in the previous survey. For instance, mobile services have increasingly diffused and 3G networks have recently been deployed. This market context is expected to offer indications and generate insight on main factors affecting mobile market's evolution path.

The supply side of Danish mobile communication market is characterized by a high concentration ratio (CR4= 77.2% and HHI=1974[1]). In terms of operators, the Danish mobile telecommunications market can be characterized as an oligopoly where five key market players (TDC, Sonofon, Telmore, Orange, and Telia) are dominant. Despite the high concentration and oligopoly nature, this market exhibits high price competition, which can be attributed to specific market characteristics. First, new entrants (Telmore, CBB Mobile and Debitel) can purchase services from incumbent mobile operators and resell them to end users. These players operate in low cost margins and drive prices of communication services at lower levels. Second, the six months subscription contracts imposed by telecommunication authority (as opposed to 24 months in the other Scandinavian countries) limit mobile devices subsidies and intensifies price competition. Third, the high Internet use rate (64%) in Denmark[2] enables network service resellers to reach mobile subscribers by using this mean as their main sales channel.

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1 The CR4 provides an indication on the percentage of market share held by the largest (here 4) firms in a market. It is estimated by summarizing the market shares of the four largest market players. CR4 less than 40 is generally considered an unconcentrated market, while measures beyond 70 are considered as highly concentrated. The HHI index provides a more complete picture as it includes the market share of all players. It is calculated by summing the squares of the market shares of every player in the market. The U.S. Department of Justice provide general guidelines for evaluating the concentration of industries or markets. A HHI below 1000 is generally pointing to a relatively unconcentrated market; a HHI between 1000 and 1800 represents a moderately concentrated market, while HHI greater than 1800 are considered highly concentrated.

2 from Eurostat, Statisitcs in focus, Theme 4-38/2003

Fourth, mobile operators are jostling to capture the segment of "younger" users and to stimulate demand for new mobile services (e.g. 3G video services and MMS).

As these users have grown accustomed to the low prices on SMS and voice calls, this has generated a "mirroring effect" to the prices on MMS and 3G services. For example, extensive campaigns were launched during 2003 offering MMS for free; and for signing up to new 3G services, mobile users could obtain three months of unlimited and free access to most of the new mobile content offered by the mobile operator 3. Finally, the barriers to unlock SIM-cards have become very low, and number portability has reduced the barriers of switching mobile operators.

The demand side of Danish mobile communications market during 2003 showed high growth rates in terms of GPRS data transfer, SMS usage as well as MMS adoption. Statistics[3] reveal that the 290,000 "GPRS subscribers" generated approximately 2,74 MB of traffic during the second half of 2003. Comparing the first and second half of 2003, there has been an increase of 105% in the number of "GPRS subscribers" that led to an increase of 145% in the download/upload GPRS rate. Moreover, the average mobile user sent more than 515 SMS in the second half of 2003. This is an increase of 63% from the first half of 2003. Although the MMS rates are bleached vis-à-vis the SMS rates, the growth rates are not. From the total 500,000 MMS sent over the Danish mobile infrastructure during the first half of 2003, this number has increased by 355% to approximately 2,3 million MMS sent during the second half. It is also worth noting that the total minutes of voice calls increased by 10.4% during this period, while the corresponding numbers on fixed networks dropped by 9%.

3. Methodology and Sampling

3.1 The survey instrument

The survey instrument was first developed in English and then translated into Danish. It was pilot tested using the staff of a university department (25) where 50% had prior experience on mobile services' usage. The questions were revised based on their feedback. Following the revision, the survey was launched on the Internet by utilizing an online software tool (SurveyMonkey[4]). The survey ran in Denmark from February to March 2004. Miller and Dickson (2001) state that on-line consumer behaviour research is a new area of academic study in marketing. They also note that most of the work in this area has been done by practitioners and strongly encourage further academic research and learning from the data of online research.

3 from the Danish National IT and Telecom Agency
4 www.surveymonkey.com

The survey instrument included 44 questions organised in different categories to provide data on mobile technology and communications' services usage, mobile services adoption and diffusion processes, mobile services' usage, Internet services' usage, 3G services adoption process and demographics.

First, we collect statistical information on mobile communications' usage patterns such as contract type, monthly expenditure, choice of operator, daily use of voice services, weekly use of SMS, as well as familiarisation with mobile devices' functionalities and mobile technologies (e.g. knowledge of GPRS). In addition, in order to reveal respondents' experience with the Internet and investigate its impact on mobile services' adoption and usage two related questions are included. In addition, a question including six statements that demands respondents to self assess their innovativeness is included. Moreover, the diffusion process is explored based on two questions relating to passive and active means used for dissemination of information. Furthermore, demographic data is collected from the respondents.

Mobile users' attitudes and perceptions on mobile services are investigated through eleven questions that including items such as the use of SMS for information purposes, but also more complicated ones such as the frequency of use of specific mobile services, and the preferences on different pricing schemes. In addition, respondents are asked two questions that relate to location awareness in order to reveal their attitudes towards commercial use of information on their exact location for the provision of customised mobile services, and for allowing interaction with other users that are in the same physical location.

In this survey we also investigate 3G services adoption process by collecting information on possession of a 3G mobile device, reasons of choosing to buy a 3G handset and use of new services, as well as satisfaction.

To address the research questions set, respondents are asked to reveal their attitudes and perceptions on mobile services through two questions that ask them first to assess the importance of the key attributes that were identified in the previous survey and then to reveal their requirements from mobile devices. The items are rated by respondents on a scale of 1-5, where 1 represented "strongly disagree" and 5 "strongly agree". The latter question asks the respondents to indicate the importance of various functionalities (e.g. colour display) and enabling services (e.g. PC synchronisation) in their decision to buy a new mobile device.

Finally, incentives play an important role in conducting a successful survey. As most Internet users have a direct and/or alternative costs in spending time online, the survey should also offer something back to the respondents in order to compensate them for the time and money spent. We offered the respondents a chance to participate in the lottery of two popular mobile phones currently sold in the Danish market. We acknowledge that the incentive may attract early adopters that are interested in new technologies but may also decrease the quality of responses since some respondents may take part on the survey

only to win the prize. The high number of respondents that already posses a similar device with the one offered in the lottery, lowers the negative impact of this effect.

3.2 The sample

The population of this research consists of Internet users in Denmark. Our target group is respondents with prior experience to similar services such as Internet users that also possess mobile phones. Convenience sampling was used. The sample size comprises 1140 respondents. The Internet has been used as a survey medium as well as for advertising the survey through banners in highly frequented portals of two universities and three private companies, including an online newspaper. In particular, if a user clicks on the banner of the webpage, then he/she is automatically redirected to the survey page. According to Hair et al. (2001) and Kinnear and Taylor (1996), convenience sampling is suitable for the requirements of exploratory research design like the present one.

The sample includes more males (61.3%) than females (38.7%), between 18 and 31 years old (52%) with monthly income exceeding 3.251 Euro (47%), and higher education (76.1%) that mainly live in metropolitan areas (48.7%) either studying (40.4%) or working in the private sector (33%). The detailed demographic characteristics of respondents are presented in Table 1.

Demographic Categories	Range	Percentage
Age Groups	18-31	52
	32-40	20.6
	41-63	25.3
	64+	1.8
Gender	Male	61.3
	Female	38.7
Household Size (i.e., no. of members)	1	24.5
	2	35.2
	3	13.8
	4	15.4
	4+	11.1
Monthly Gross Income (in Euros)	0-1000	14.2
	1001- 2000	12.9
	2001 – 3250	11
	3251 – 5000	13.7
	5000 +	33.8
Education	Below High School Degree	9.1
	High School Degree	14.8
	College/University	46.1
	Postgraduate	30
Size of Town	Less than 20.000	15.3
	20.000 – 100.000	36
	Over than 100.000	48.7
Occupation	Employed in the commercial sector	9.3

Executive / manager	10.1
Computer Engineer	2.8
Student	40.4
Employed in the social sector	7.3
Professional	3.3
Technician / Engineer	3.1
Academic / Educator	7.5
Self-employed	3.5
Employed in the public administration	2.6
Tradesman / Craftsman	0.9
Retired	2.1
Homemaker	0.3
Other	6.9

Table 1. Demographic Characteristics of the Sample

The sample size is influenced by Internet and mobile penetration as well as the advertising effort for the online survey. The sample is not representative of the total Danish population since it includes self-selective Internet users. However, the intense advertising campaign and the balanced mix of internet pages hosting links to the survey (e.g. commercial and university portals) have counterbalanced part of this shortcoming.

3.3 The Hypotheses

The survey delves into the attitudes and behaviours of users with respect to mobile services, sources of influences and innovation. In this paper we investigate whether the identified key attributes of mobile services market evolution as well as the perceptions and attitudes have changed in the relatively more mature market context of Denmark for both mobile users and shoppers. The null (H_0) and the alternative (H_1) hypotheses are formulated as follows:

H^{I}_0: Danish mobile users and mobile shoppers attach the same importance to the identified set of attributes

H^{I}_1: Danish mobile users and mobile shoppers attach significantly different importance to the identified set of attributes

H^{II}_0: Danish mobile users and mobile shoppers attach the same importance to mobile devices' functionalities

H^{II}_1: Danish mobile users and mobile shoppers attach significantly different importance to mobile devices' functionalities

4. Results and Discussion

4.1 Data analysis

The majority of respondents own a mobile device (99%). However, since the sample includes only Internet users, this finding should be interpreted with caution. The subscription type of mobile contract was chosen by 62.1% and prepaid by 37.9%. As far as the purpose of mobile use is concerned, the majority of respondents (76.4 %) use their mobile devices exclusively for private purposes.

With respect to mobile devices diffusion 31.5% of the respondents reported that they have 4 to 6 years experience with mobile devices, and 37.5% have more than 6 years of experience. However, in terms of current device, it was found that the majority of Danish users (49.2%) owned their current mobile phone for less than one year. The majority of the respondents (49.6%) reported that their daily calling time fluctuates between 0 to 5 minutes, and send between 6-20 SMS per week (31.5%), while most of respondents (25.3%) spend on average 10 Euros per month for mobile communications. This observation corresponds to the official statistics released by the Danish Ministry of Telecommunications and Innovation[5]. The decrease in daily calling time underlines the need for mobile operators to diversify their service offering and seek for new revenue sources. Moreover, it indicates that mobile users' attitude towards mobile communication as such has changed.

The previous indication may be explained by the responses on what is the most important reason for using mobile devices, which, was found to be the "independence of location and time" (63.5%). If this criterion is combined with the decrease in calling time, it indicates that mobile communication is perceived as means of contacting people that allows "reachability" anywhere, anytime. Moreover, other important criteria were "convenience" (50.5%), the "curiosity" (34.6%) and the "fun and entertainment" (34.1%).

Criteria	Percentage
Low pricing schemes	59.8
Special offers for new subscribers	15.3
Good coverage	37
Good service quality bundled with the contract	9.7
Reputation	24.2
My friends have chosen the same provider	2.2
Company telephone	15.5
Good Customer Service	15.2
Other	14

Table 2. Mobile Operator Selection Criteria

5 www.si.dk

The most important criterion for the respondents on selecting a mobile operator was found to be the "low pricing schemes" (59.8%), which seems to stimulate the current price competition in communication services. Moreover, "good coverage" was evaluated as the second criterion (37%) and "operator' reputation" as the third (24.2%). On the other hand, the least important criterion is "my friends have chosen the same provider" (2.1%). Table 2, provides the detailed data regarding the criteria that customers use in order to select a mobile operator.

Furthermore, respondents were presented with some broad categories of mobile services and asked to report, which ones they have used and recommended to others. Information and news' categories were found to be the most popular in both terms of use as well as recommendation followed by, banking and financial, entertainment and ticketing categories. The least used mobile services' categories were found to be travel booking and shopping. Table 3, illustrates these findings. However, it should be noted that a considerable percentage of mobile users have not used any of the alternative mobile services in the past (83%).

Services' Categories	Usage	Recommendation
Banking and financial services	75	36
Shopping	17	14
Entertainment	59	30
Information and News	128	49
Travel booking	26	18
Ticket reservation	47	26

Table 3. Mobile Services Usage and Recommendation (total number of users)

We separated our sample into two groups of respondents, those that are using only voice and SMS services and those that are also using other services. Accordingly, we found 414 respondents that have use mobile services, other than voice and SMS. A major classification between mobile users (i.e., those that have not used any of the services included in Table 3) and mobile shoppers (i.e., those that have used at least one mobile service included in Table 3) was made in order to investigate whether there are significant differences between the perceptions and attitudes of these groups. t-Tests were used to investigate whether the two identified groups (i.e., mobile users and mobile shoppers) attach equal importance to the identified factors/attributes. The results (Table 4) indicate that mobile users attach similar importance to all the investigated attributes with mobile shoppers.

t-tests for Equality of Means assuming unequal variance						
Mobile services' attributes	**Mobile Users 235**	**Mobile Shoppers 139**	**t**	**Sig.**	**p-value**	**Hypotheses testing**
Ease of Use Interface	2,54	2,61	-0,732	0,46	p>0,05	Cannot Reject Ho
Security	2,60	2,44	1,550	0,12	p>0,05	Cannot Reject Ho
Customer Service	2,91	2,89	0,209	0,83	p>0,05	Cannot Reject Ho
Price	3,84	3,65	1,780	0,075	p>0,05	Cannot Reject Ho
Personalisation	3,02	3,11	-0,940	0,34	p>0,05	Cannot Reject Ho
Comfort of Device	3,21	3,33	-1,080	0,27	p>0,05	Cannot Reject Ho

Table 4. Mobile t- Tests Results for Mobile Users versus Shoppers perception on mobile services' attributes (1: Completely Unimportant – 5: Very Important)

The results of Table 4 show that mobile users become more mature. In particular, mobile users and shoppers attach equal importance to the key identified factors affecting mobile services adoption and diffusion, such as price, comfort of device, personalization, customer service and security. These indications offer initial insight to mobile operators and service providers on how to address the needs of this market segment through services development and marketing strategies.

Moreover, in order to better understand the profiles of the two groups we investigated their demographic characteristics. The majority of mobile users are females (51%), students (42%) whereas mobile shoppers are men (74%) working in the private sector (39%). The monthly income is above Euro 3.250 for 37% of mobile shoppers and for 28% of mobile users respectively whereas their monthly payment for mobile communications is below 30 Euro for 61% of mobile users and 43% of mobile shoppers.

In terms of voice services mobile users reported less than 5 minutes daily (45%) and mobile shoppers between 5 and 10 minutes (34%). Finally, in terms of SMS mobile users send more than 20 weekly (38%) and mobile shoppers between 620 weekly (35%), whereas in terms of MMS both users (45%) and shoppers (51%) stated that they use it "now and then".

Furthermore, mobile devices' have a critical role in the diffusion and use of mobile services. They may facilitate or impede the use of mobile services. For example, the colour display is a critical factor in case of video services. In order to understand the users' requirements for mobile devices' functionalities the respondents were asked to assess their importance. Functionalities range from polyphonic ring tones to location sensitive ones. We investigate whether mobile users and mobile shoppers attach the same importance in the various functionalities in order to better understand their characteristics and differences. Table 5 presents the t-Tests results for the two groups.

t-tests for Equality of Means assuming unequal variance						
Mobile devices' functionalities	**Mobile Users 235**	**Mobile Shoppers 139**	**t**	**Sig.**	**p-value**	**Hypotheses testing**
Colour Display	3,93	4,20	-2,22	0,02	p<0,05	Reject Ho
Camera	2,94	3,34	-2,88	0,004	p<0,05	Reject Ho
Video	2,17	2,61	-3,30	0,001	p<0,05	Reject Ho
Radio & Music Services	3,01	3,25	-1,70	0,09	p>0,05	Cannot Reject Ho
Polyphonic Ring tones	2,71	2,91	-1,37	0,17	p>0,05	Cannot Reject Ho
Broadband Internet functions	3,03	3,62	-4,26	0,000	p<0,05	Reject Ho
Email service	3,21	3,92	-5,34	0,000	p<0,05	Reject Ho
PC Synchronisation	3,42	4,06	-4,58	0,000	p<0,05	Reject Ho
Messenger	2,08	2,33	-1,88	0,06	p>0,05	Cannot Reject Ho
Map and positioning	2,95	3,45	-3,76	0,000	p<0,05	Reject Ho
Games	2,13	2,37	-1,81	0,07	p>0,05	Cannot Reject Ho

Table 5. t- Tests Results for Mobile Users versus Shoppers requirements on mobile devices' functionalities (1: Completely Unimportant – 5: Very Important)

Table 5 offers initial indications on the difference between mobile users and shoppers. Mobile shoppers attached higher importance to the functionalities of devices relating to service quality than mobile users. The improved colour display is the most important functionality for both groups (33%) but mobile shoppers attach higher importance than users. The second important functionality is PC synchronization to access calendar and emails (31%) and again mobile shoppers and users attach different importance. To our surprise, the least important criterion for buying a new mobile device under study is games (57%) and both mobile users and shoppers attach the same importance. With respect to the mobile devices, the majority of mobile users (37%) and shoppers (49%) have been using them for more than six years. However, the majority of mobile users (33%) and shoppers (33%) have bought the current device during the last year. The latter observation combined with the results of Table 5 indicates that both mobile users and shoppers have specific requirements that are not addressed even from relatively new models of mobile devices.

4.2 Evolution path of mobile service market

Returning to the results of Table 4, "price" was found to be the most important factor pertaining the attitudes of both mobile users and shoppers, implying that the cost of using mobile services remains critical for their diffusion. It should be noted that this finding is in line with the results of the study discussed in section 2, which proved that "high price" constitutes one of the major obstacles towards mobile services' diffusion.

Moreover, "comfort of device" was found to be the second most important factor for both mobile users and shoppers. Mobile users become experienced and informed regarding the various mobile devices available in the market. Therefore, they seek devices that are "easy to use" when accessing mobile

services. Apparently, the high sophistication of some devices that incorporate the latest technological advances makes them unattractive to mobile users that prefer easy and simple access to the new services. The recently released official statistics on mobile traffic for the second half of 2003 also underpins this finding, as less than 3500 persons had adopted the only 3G handset in the Danish market (e.g. the technologically sophisticated Motorola A920).

Furthermore, "personalization" and "customer service" were also important attributes for both mobile users and shoppers. These factors indicate the maturity of Danish market, where there are more experienced and informed consumers regarding the variety of available mobile services that have specific requirements that expect to be addressed. The reported importance of these factors also highlights the emerging business opportunities for services' differentiation that may enable the involved companies to create competitive advantages and avoid price competition.

On the contrary, "security" and "easy to use interface" were found to be relatively less important attributes for the respondents. As far as "security" is concerned, this does not keep pace with the fact that one of the most important reasons that Internet users do not shop through the Web concerns security issues. A possible explanation is the current relatively low use of mobile services involving online financial transaction and revelation of sensitive information. In addition, the issue of "easy to use interface" has not become unimportant, but has been "taken for granted" since mobile handsets have become more focused on easy to use interfaces, and that routine use tends to diminish the perception of difficulties to use.

The results of Table 5 can be used to elaborate on the perceptions and requirements of the two groups under investigation with respect to the mobile devices' functionalities. The increasing demand for quality of service in terms of colour display and broadband access as well as the need for PC synchronisation and email services, underline the critical role of devices in the diffusion of mobile services. Mobile shoppers, having used mobile services attached higher importance on the technical characteristics of their devices than mobile users that also consider them critical. On the other hand, functionalities that relate to entertainment such as music/ radio functions or games are not considered very important for both shoppers and users. The requirements for specific functionalities combined with the importance of "comfort of device" attribute indicate that new mobile devices should be further customised to enable diffusion of mobile services.

This discussion highlights the role of mobile users, which at the same time are Internet users in the evolution of mobile services market. The results of this survey indicate that this market segment is maturing rapidly. Thus, it constitutes a target segment for mobile services' providers and it offers new business opportunities for differentiation that should be investigated in their strategic marketing planning. Services customisation and specific marketing campaigns should be designed to address the characteristics of this emerging customers' group. For example, promotional messages' could offer bundles

of mobile services free of charge for a trial period, or provide step-by-step guidelines on the activation of specific applications, or services. Moreover, different strategies could be designed for mobile shoppers to stimulate their use of mobile services. Furthermore, close collaboration of mobile operators and service providers with device manufacturers is warranted to address both groups' requirements in terms of device functionalities.

5. Conclusions, Implications and Future Research Directions

Mobile shoppers and mobile users' attitudes towards mobile services' attributes do not significantly differ. These results indicate that mobile services adoption in the Danish market is accelerating. Mobile users' market segment has matured and is about to adopt mobile services. As far as the perceptions on mobile devices' functionalities, mobile shoppers, having used mobile services, are not satisfied by the quality of service offered and they have requirements for better synchronisation with their PC and email services. Mobile service providers can use the results of this survey to identify the profile of their current and potential customers towards effectively customising their services offerings. To that end, the present study revealed on one hand some critical factors pointing towards acceleration of mobile services' adoption, and on the other, that new business opportunities have emerged from the market potential of mobile users that should be exploited.

Furthermore, the critical role of consumer behaviour research in the mobile industry was underlined and justified. However, there is a strong need to conduct in-depth consumer behaviour surveys focusing on specific market segments. It is also important to note that the dynamics of perceptions should be investigated by continuous market research in order to respond to and better anticipate changes in preferences, needs and wants. For this, surveys are an adequate tool, but may be supported by qualitative research based on focus groups and interviews.

Further research can elaborate on the findings of this exploratory study by setting specific research hypotheses based on the insight generated. For example, focus groups may be used to elaborate on the observation that mobile users do not heavily use communication services but appreciate the feeling of "anytime anywhere reachability" that is being offered. Moreover, experiments can be conducted to investigate mobile services usage patterns and test hypotheses such as whether there are significant differences between the two segments' willingness to pay for mobile services. This type of research may provide direct managerial implications for mobile service providers and enable them to offer bundles of services for specific market segments. The authors of this paper currently study the social dynamics and price elasticity of two user segments in a field experiment. In the experiment participate 40 people that are offered

new mobile phones and pre-paid SIM cards.. We investigate how additional resources are allocated to various mobile services, as well as collect and analyse data in order to identify opportunities for versioning and bundling of mobile service.

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Event-Based Actor Network Analysis of ICT-Based Change

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***Abstract**: This paper reviews published actor network theory (ANT) analyses of ICT-based changes and offers a new way in which to structure and report such efforts. The argument is based on a longitudinal case study of a system implementation effort in a hospital to transform information processing related to radiology examinations from paper based to electronic form. The proposed approach adopts ANT to understand and assess an ICT-based change as follows: First, in the analysis, de-stabilizing events occurring in the change process are identified to structure the analysis. Second, each de-stabilizing event leads to a focused actor network analysis of the network configurations related to the event. Third, these analyses are synthesized into an overall understanding of the ICT-based change. The paper explicates the proposed approach to ANT analysis, it presents the lessons learned from analyzing and presenting the case, it compares and contrasts the approach with other approaches to ANT analysis, and it discusses the findings and their implications for the use of ANT to analyze ICT-based change.*

***Keywords**: Actor network theory, Event-based analysis, ICT-based change.*

1. Introduction

Actor Network Theory (ANT) has been successfully adopted to study changes enabled by Information and Communication Technology (ICT). Several case studies based on ANT analyses have provided valuable insights into the nature of ICT-based change in organizations including: responsibility accounting and the constitutive role of accounting systems in hospitals (Bloomfield et al, 1992); boundary disputes between the technical and non-technical in healthcare and financial services (Bloomfield & Vurdubakis, 1994); transformation of work (Boland & Schultze, 1996); infrastructure and classification (Bowker et al, 1996); network building (Doolin, 1999); information infrastructure and inscriptions (Monteiro & Hanseth, 1996; Hanseth & Monteiro, 1997); temporal zones (Scott & Wagner, 2003); stakeholder maps in order to take into account multiple interests (Vidgen & McMaster, 1996), and embedded Trojan actor network to explain escalation (Mähring, Holmström, Keil & Montealegre, 2004).

ANT has also been applied to ICT-based change within public institutions and society at large, for example concerning cash-cards in Sweden and recognizing the need for multi-purpose networks (Holmström & Stalder, 2001); the link between enrolment strategies and inclusion in the personal digital assistant industry (Allen, 2004); the shaping of the web browser (Faraj, Kwon & Watts, 2004), and concerning implementation and use of geographical information systems (GIS) in a district-level administration in India (Walsham & Sahay, 1999). Further, ANT has been applied to ICT-based change within biotech, for example concerning taxonomy in botanical plant categorization (Hine, 1995); concerning the nature and social construction of time related to ICT-based change of control systems in a pharmaceutical plant (Kavanagh & Arajou, 1995), and concerning reliability of lay health information on the Internet (Adams & Berg, 2004).

While these case studies demonstrate the feasibility of ANT as a framework for understanding ICT-based change, they also raise a number of issues related to structuring and reporting from such studies: what is the unit of analysis, where do networks begin and end, what is the extension of an actor, on what level do you conduct the analysis, and how do you practically manage the veritable mass of details that the approach easily lead to because of its flexibility and the generic nature of its vocabulary? Based on such concerns, Walsham (1997) suggests that we need further experimentation to improve the way we structure and report ANT analyses of ICT-based change.

In response to this challenge our paper investigates and presents a new approach to structuring and reporting ANT analyses of ICT-based changes. Our aim is to contribute to the methodological literature on ICT-based change in organizations within the information systems (IS) discipline. We have reviewed existing actor network analyses of ICT-based changes and provide on that basis the rationale for and the experiences with a particular approach to ANT analyses. We distinguish between methodological use of ANT for data

collection by 'following the network', the structuring of the ANT analysis of the data, and the subsequent reporting of the data and the findings. Our emphasis is on structuring and reporting the ANT analysis.

Our approach to retrospective analyses of ICT-based change processes introduces the concept of de-stabilizing events as a key mechanism to structure and report the analysis. De-stabilizing events refers to something that causes disturbance in the existing stable networks in the change process. These de-stabilizing events are identified in relation to particular configurations of actor networks. The analysis is structured and presented chronologically starting with a de-stabilizing event that is perceived to initiate the change process (e.g. a decision to adopt a particular ICT-based solution or the initiation of a project to achieve this) followed by subsequent modifications of the configurations through other de-stabilizing events (e.g. outsourcing the project to a vendor or organizational rejection of a first version of the solution).

Our methodological illustration is based on a longitudinal case study of a system implementation effort in a hospital. The purpose of the implementation effort was to transform information processing related to radiology examinations from paper based to electronic form. Our argument is structured as follows. First, we present the theoretical background from three literature areas: an introduction of ANT; the ongoing discussion of ANT analyses in IS research; case studies that have adopted ANT to research ICT-based change. Second, we present our research approach, i.e. the rationale for and our approach to event-based actor network analysis of ICT-based change. Third, we present the case with selected de-stabilizing events as the overall chronology, we provide a detailed ANT analysis of how each de-stabilizing event causes the configuration to react through a series of translations and negotiations until a stable configuration has emerged, and we assess how our understanding of the overall ICT-based change is informed by the adopted sequence of actor network analyses. Fourth, we use the methodological illustration to critically consider advantages and disadvantages of the proposed approach to structure and present ANT analyses compared to other approaches to ANT analyses of ICT-based change. Finally, we conclude the argument and discuss its implications for event-based approaches to understand organizational diffusion of ICT.

2. ANT Approaches to ICT-Based Change

2.1 Actor Network Theory

ANT has its roots in sociology science (Latour, 1987; Callon, 1986) and aims to understand the processes that lead to construction and transformation of sociotechnical networks (Callon & Law, 1989). The focus is on how people and objects are brought together in stable, heterogeneous networks of aligned interests (Law, 1991) through processes of translations and negotiations (Callon, 1986; Callon & Law, 1989).

One must realize that ANT has frequently been revised and extended, and there is, therefore, no unified body of knowledge. There are, however, some relatively stable key elements of the theory (Walsham, 1997). The purpose of this paper is not to discuss variations in the theory, but to look into how ANT analyses are structured and reported, the details of ANT variations aside. In Table 1 we summarize some of the key concepts in ANT (modified from Walsham, 1997).

Concept	Description
Actor (or actant)	Any material, i.e. human beings or nonhuman actors
Actor-network	Related actors in a heterogeneous network of aligned interests
Translation	How actors generate ordering effects by negotiating or maneuvering others' interest to one's own with the aim to mobilize support
Inscription	Embodied translations into a medium or material
Enrolment	Mobilize support by creating a body of allies through translations
Irreversibility	The degree to which it is subsequently impossible to go back to a point where alternative possibilities exist
Black box and punctualisation	A temporary simplification of a network that acts as a single unit so that the network efface into one actor
Immutable mobile	A materialized translation that can be interpreted in essentially the same way in a variety of contexts

Table 1. Key Concepts in Actor-Network Theory

A core assumption in ANT is that no actor is different in kind from another. Instead, how size, power or organization is generated should be studied unprejudiced (Law, 1992). The inclusion of non-humans in the networks is explicitly an analytical stance, not an ethical position, and the term 'heterogeneous network' is used to articulate the inclusion of both humans and non-humans, i.e. any material one cares to mention, and the ordering and organizing of these.

The argument behind this view is that the social is not simply human; it is all these other materials too (Law, 1992). That is, when people interact with other people, they are mediated through objects of various kinds, and such interactions are in turn mediated through additional networks of objects and people. The view is that these various networks both participate in and shape the social, and therefore, if the material in these networks would disappear, the so-called social order(s) would too (Law, 1992). Hence, the view in ANT is that a particular order is an effect generated by heterogeneous means. An actor is seen as produced from or as an effect of these heterogeneous relations between people and objects, and an actor is also, always, a network (Law, 1992).

An actor-network that is known and predictable in a certain situation and context can be assimilated into a black box. Such a punctualisation is a

temporary simplification of a network that acts as a single unit so that the network behind can be effaced into one actor (Callon, 1987; 1991; Law, 1992).

Translation (Callon, 1986) is a verb that that implies transformation, which refers to how actors engage with other actors to generate ordering effects (Law, 1992). Callon (1991) emphasize that translation goes beyond the traditional definition of action as it deals with mutual definition and inscription. Actors negotiate or maneuver others' interest to one's own with the aim of enrolling actors into the network. When such translations get embodied into a medium or material they are referred to as inscriptions (Akrich, 1992). Such inscriptions prescribe a program of action for other actors, although they can vary in strength and flexibility (Hanseth & Monteiro, 1997).

Inscriptions may lead to irreversibility, which refers to both the degree to which in a certain situation it is impossible to go back to a point where alternative possibilities exist, and the extent to which it shapes and determines future translations (Callon, 1991; Hanseth & Monteiro, 1997). A materialized translation, hence mobile, that can be interpreted in essentially the same way in a variety of contexts (i.e. relatively stable in space and time) is referred to as an immutable mobile. Such immutable mobile entities often possess strong properties of irreversibility, e.g. software standards.

2.2 Critical reflections on ANT analysis

In a review of the use of ANT, Walsham (1997) recognizes four main areas of critique in the literature: ANT's disregard for social structures; its disregard for moral and political analysis; its symmetric treatments of humans and non-humans; and its power to describe as opposed to explain, together with the problem of managing veritable masses of detail. Walsham concludes that although the criticism suggest some cautions to the researcher using the theory, ANT could without difficulty be supplemented by other social theories to deal with social structures, moral or power when needed, and also that we can make use of ANT without accepting full symmetry between humans and non-humans. In relation to the problem of managing the complexity of details that emerge from adopting ANT, Walsham suggests experimenting to improve our ways of structuring and reporting from such studies.

Latour (1996) emphasizes that heterogeneous networks overcome issues related to identity and avoid arbitrary dichotomies and structures. "Each element in the network is simply defined by the heterogeneous list of its associates. […] Essence is existence, and existence is association" (p 303). Entities are hence defined through their existence and their specific associations with other entities and they are not substitutable. However, Latour recognizes limitations to this approach; entities "become empty when asked to provide policy, pass judgment or explain stable features" (Latour, 1996, p 304). Therefore, a supplement is needed, different than essences or structures. A specification of

the types of associations will not suffice, "since, by definition, the number of types will be as large as the multiplicity of associations" (Latour, 1996, p 304). Some supplements have been offered (Latour, 1996) for example the notion of fluid (Mol & Law, 1994), which adds movement to networks. The aim has been to keep the freedom and flexibility offered by the ANT analysis, "but to overcome the limits of actor-networks in specifying the trajectories traced by those free associations" (Latour, 1996, p 304).

Monteiro (2000) discusses the particular issues related to identifying actors. He advocates, in line with e.g. Callon (1991) and Law (1992), that ANT provides a uniform framework regardless of the chosen unit of analysis. There is, he argues, no a priori size of the network or between the micro, meso, and macro levels of analysis. Instead, ANT analyses are scalable: "the 'actor' of analysis is of the 'size' that the researcher chooses as most convenient relative to the direction of the analysis" (Monteiro, 2000, p 82).

Hanseth, Aanestad and Berg argue that, "ANT can provide IS research with unique and very powerful tools to help us overcome the current poor understanding of information technology (IT) artifact" (2004, p 116).

2.3 Approaches to ANT analysis

Reviewing published ANT analyses of ICT-based changes we have identified a number of ways to structure and report ANT analyses. Both the context and the focus of the reviewed differ widely, and consequently, it is a challenge to adequately categorize them. At the expense of reducing the richness of each analysis, we have attempted to capture the main principles applied in structuring and presenting each analysis in order to understand present approaches to dealing with the complexity of ANT analysis and to identify alternative options. Our review has led us to identify four different principles for structuring and presenting ANT analysis of ICT-based change: network-centric; actor-centric; time-centric, and event-centric.

Network-Centric - The networks-centric principle adopts network as the major structuring mechanism for the analysis. These analyses follow in this way the core construct of ANT. A paper exemplifying this approach is the study by Walsham and Sahay (1999) concerning implementation and use of GIS in a district-level administration in India. Their analysis of the evolution of the network is structured in four sections: creating the network for project initiation; maintaining the network during project development; extending the network to district-level administrators; and their own role as researchers in the actor-network. The report is about twenty-four pages in total of which the analysis is about five pages.

Actor-Centric– The actor-centric principle focuses on the actors, human and non-humans, and their translations and negotiations of some other ANT aspect. An example is the study by Hanseth and Monteiro (1997) about the construction of information infrastructure standards in the Norwegian healthcare focusing

on inscriptions. In contrast to the network-centric approach this approach primarily structures the analyses on actors rather than networks as in the mentioned example: constructing the need for open standards; technology as ally; EDIFACT as actor; enrolling the general practitioners; aligning interests; the irreversibility; peaceful life outside the network; the message as a material for inscription and accumulating the strength of an inscription. The paper is about twenty-seven pages of which the analysis is about fourteen pages. Another example of the actor-centric principle is the study by Bloomfield and Vurdubakis (1994) about system development in healthcare and finance. Their focus is on how the boundary between the technical and social in the development of ICT systems is negotiated by the actors in processes of translations. In their report, however, the analysis is only structured by the heading separating the two cases at study, healthcare versus finance. The report is about fourteen pages in total of which the analysis is about eight pages.

Time-Centric - The time-centric principle adopts time as the central mechanism for structuring the analysis. Time is not explicitly articulated in ANT, as pointed out by Kavanagh and Arujo "actor-network theory hasn't, so far, put forward its own view of time and temporality" (1995, p 107). An example of a time-centric approach is the study by Scott and Wagner (2003) about an organization–wide enterprise resource planning technology focused on how order is achieved during ICT-based change. The analysis is structured using the notion of temporal zones: the historic vision surrounding the project; the creation of the project; and the attempt to achieve order. The paper is about twenty-five pages in total of which the analysis is about ten pages. The study by Kavanagh and Arujo (1995) is another example of a time-centric approach. It is about the nature and social construction of time related to ICT-based change of control systems in a pharmaceutical plant. The analysis is structured in: networked time; inscribed time; folded time; durable time; and dynamic time. The paper is about sixteen pages in total of which the analysis is about eight pages.

Event-Centric– The event-centric principle focuses on events as a principle for structuring the analysis. An example is the study by Holmström and Stalder (2001) about the attempt to introduce cash-cards in the Swedish society. They combine ANT with theory of technology drift and they use events to structure and present the case: the trial introduction of the cash-card; the nationwide rollout of the cash-card; the cash-card as a failure of diffusion. The following analysis is structured as follows: understanding IT infrastructure drift, and drifting technologies from single-purpose to multi-purpose networks, offering explanations to the described events. The report is about seventeen pages of which the analysis is about five pages.

Organizational change occurs over time. The chronological view of time only represents one of many notions of time (Adam, 1995; Kavanagh & Arajou, 1995; Scott & Wagner, 2003), and changes or disruptions have not yet been adopted in time- or event-centric ANT case studies. In fact, we have not found any studies that use transformational or de-stabilizing events to structure the

presentation. Many reports do, however, focus on the engagement of allies in translations and negotiations to achieve order and reach alignment (e.g. Scott & Wagner, 2003). Callon and Law (1989) emphasize that all translators "select and constitute traditions which will frame their innovations in the most favorable manner, reinforce them, and generally afford them a satisfactory environment", and, consequently, a "construction and interpretation of tradition is almost always a matter for controversy" (p79). When adopting de-stabilizing events to structure and present ANT analyses of ICT-based change, this notion of controversy is useful because de-stabilizing events imply controversy between actors in the networks.

3. Research Approach

Our research focuses on how de-stabilizing events can be used to structure reports from actor network studies of ICT-based changes. More specifically we ask what the advantages and disadvantages of such an approach are and whether it helps structure and report the veritable mass of details that ANT studies offer. Our argument is based on a longitudinal interpretive case study (Walsham, 1993; 1995) of an ICT-based change process transforming information processing related to radiology examinations in a hospital from paper based to electronic form. The purpose of this study is to learn about ICT-based change in complex organizational settings. The study was guided by ANT (Latour, 1987; Callon, 1986; Callon & Law, 1989; Law, 1991) and we have followed the involved actor-networks to gain an understanding of the change process. The starting point of our research is the decision to replace the paper-based order forms and the initiation of the pilot project. In this paper we trace and analyze the actor-networks within the hospital that are involved in this change process.

We adopted a combination of different techniques for collecting data: observations of daily work, interviews, participation in meetings and seminars, studies of documents and the ICT system, and continuous informal discussions with the involved project managers and care professionals. In addition to the formal data collection, we spent several days at the hospital with informal interactions with personnel and we had many follow-up contacts over telephone and email with the project management. The data collection started in October 2001.

During autumn 2001 and spring 2002, we participated in 10 project meetings for the new order form system for radiology examination. Each meeting lasted about two to three hours during which we were taking notes. In May, June and September 2002, we conducted forty hours of observation of daily work, also taking notes, at the different departments and professions at the clinic. Between February and May 2003, twelve semi-structured interviews were conducted, each between 30-90 minutes long that were recorded and transcribed. The interviews covered questions of how the users perceived the

system and its impact on their work practice. Different professions involved in the clinical work have been considered: physicians, nurses, assistant nurses, and secretaries with different responsibilities. In March 2004, three interviews with the IT director and two project managers were conducted, recorded, and transcribed.

ANT focuses on continuous creation and maintenance of stable heterogeneous networks through the enrolment of allies through translations and negotiations of interest. A stable heterogeneous network is achieved when the involved actors have aligned their interests and stability might sustain as long as interests are aligned. When events disrupt the temporary order of aligned interest a new process of translations and negotiations occur until some new stable networks are achieved eventually leading to modified or different configurations.

Most ANT analyses have focused on the efforts to achieve this order. Instead, we choose to structure and present the analysis based on the de-stabilizing events themselves. A de-stabilizing event refers to something that causes disturbance in the existing stable networks. A simple example is the decision to replace the paper-based order forms for radiology examination. This decision led to initiation of a pilot project that caused disturbance in the initial network configurations amongst the involved actors. In the analysis of the collected data we have looked for statements or events that indicated such disruptions. For example, user statements or questions related to the change process, decisions in the change process, user rejections to decisions or explicit plans, or other disturbances that arose related to the change process. The de-stabilizing events have been selected in the light of retrospection and the outcomes of the process.

A previous ANT analysis of this particular study (Nilsson et al., 2003) provided insights into selected translation and negotiation incidents. We experienced, however, serious problems in choosing what to include and not to include in the study, and ANT did not suggest ways to structure and present the overwhelming amounts of data and the many different possible ANT interpretations. These experiences led us to this methodological approach where we seek help to present the case by adopting de-stabilizing events as the key structuring mechanism.

4. Case Description

The change process unfolded in a Swedish emergency hospital owned by the county council, serving a population of approximately 360,000. The background to the change process was the digitalization process of the radiology department that started in 1998. This involved the development of a radiology information system (RIS), which registered patient and examination data, and a purchased standard picture archiving communication system (PACS), which stored images. In order for the radiology ward to escape the

manual registration work and to fully benefit from the digitalization, the replacement of the paper-based order forms plays a crucial role. The decision to implement the electronic order form system hospital wide was made at the top level by the hospital director and the managers from the involved clinics.

In the paper-based information processing of radiology examinations, the physicians at the clinics made requests to the radiology department on standardized paper forms, often assisted by nurses or secretaries in various ways. Generally, the requests were sent through a pneumatic tube system in the hospital to the radiology ward. The receiving radiologists and assisting administrative and technical staff at the radiology ward generated the response documents, and these were subsequently sent back through the pneumatic tube system.

The electronic order form system should connect the radiology department to all clinics via the electronic patient record system (EPR), see Figure 1. The order form system was expected to benefit the hospital as a whole as well as the radiology department. Specifically, the system should lead to improved service and timesaving for searching after lost and misplaced documents.

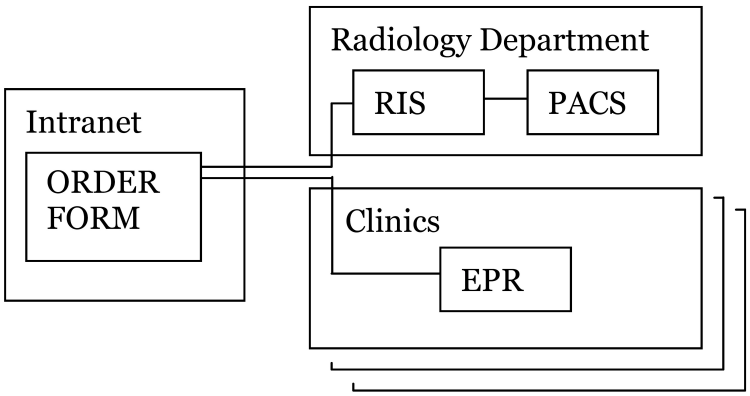

Figure 1. Key elements in network configuration.

The system was set up with access via the EPR requiring the user to logon to the network, the EPR and then start the order form, see Figure 1. The management's arguments for user access via the EPR were related to safety issues and the intention to make the user perceive the EPR and the order form system as one system.

The project management for the order form system was divided into two sub-project areas under the main project manager of the radiology digitalization. One was responsible for the design process working with the supplier of the system. The other was responsible for supporting the clinics in preparing for the implementation of the system. The project management chose the orthopedic clinic for pilot clinic, based on the assumption that it would be the most challenging clinic to attain acceptance for the system.

The sub-project manager formed a group of representatives from the pilot clinic to analyze current routines and anticipated changes. This group met about ten times, approximately 2-3 hours each time, and analyzed current routines, division of labor and responsibilities, and discussed possible changes when the system was implemented.

A first text version of the order form system was implemented as parallel adoption process at the pilot clinic in May 2002 (i.e. to write requests and read answers became available through the system, but not yet the images). In spite of the preparations efforts, the pilot clinic was rather unprepared for the event and a fairly disorganized period followed.

The sub-project manager perceived the situation as beginners' problems that would be solved over time with practice and appropriate routines. Consequently, the project management tried to convince the clinic to proceed and fully replace the paper forms with the system. However, the parallel adoption process maintained over the summer and the project management instead planned to advance and implement the system at the entire hospital in September.

The situation in September was still disorganized and when the clinic became aware of the project management's plan to implement the system hospital wide, they, together with other clinics, opposed and demanded that the system should be improved before further implementations. As a result, the project management postponed further implementation and instead worked on improving the system.

At this point, a new physician at the pilot clinic became engaged in the project and the process of improving the system. The physician identified problems, tested new versions, and collected viewpoints from his colleagues about functionality and the user interface. In November 2002, the first image version of the system was implemented at the pilot clinic (i.e. the requesting physicians could access the digital images through the system).

In March 2003, the system was implemented hospital wide. There were, however, still problems with the system in terms of performance and stability. Consequently, the users at the different clinics collectively demanded additional improvements. After some additional months of efforts to improve the system, the collaboration between the project management and the supplier were in serious problems, holding each other responsible for the insufficiencies of the system. At the end of year 2003, the collaboration with the supplier was ended and in March 2004 a substituting supplier was engaged to rebuild the system.

5. Event-based Actor Network Analysis

Before the analysis that follows we establish the chronological order of identified key de-stabilizing events, see figure 2. The listed events have been

chosen on the basis of how they disrupted the existing network configurations involved in the replacement process. Each selected de-stabilizing event caused controversy among the involved actors in an actor-network and disrupted a temporary order resulting in negotiations and translations to achieve a new stability.

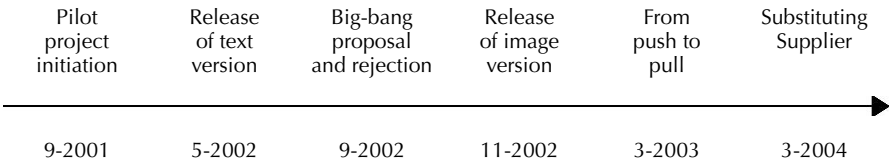

Figure 2. De-stabilizing events in chronological order.

5.1 Pilot project initiation

The first de-stabilizing event was the 'Pilot project initiation' (see Figure 2) in September 2001. The sub-project manager formed a group from the orthopedic clinic that would analyze current routines and consider appropriate changes when the paper-based order forms were replaced with electronic, in order to prepare the clinic for the new actor, i.e. the electronic order form system.

The de-stabilizing character of this event was the implied challenge to the existing configurations of the actor-networks at the clinic from the discussions about the new actor and related changed routines. One simple issue that illustrates this is the discussions whether the physicians should complete the forms single-handed when the new system had been introduced. The order in the actor-networks at the clinic was that physicians often were assisted by secretaries and nurses concerning much of the routine work related to the paper-based order forms.

The secretaries and nurses allied together and translated their interest so that it was inscribed into the electronic order form system that only physicians were authorized to write an order form, while other actors were only authorized to read. Such issues were subject for continuous translations of interest and negotiations between the actors in the group that resulted from the pilot project initiation.

5.2 Release of text version

The second de-stabilizing event was 'release of text version' (see Figure 2) in May 2002. The new actor, the electronic order form system, was released with parallel adoption and coexisted with the paper-based forms.

It turned out that much of the discussions from the group had not been successfully disseminated to the actor-networks at the clinic. Consequently,

the physicians, the main assigned user of the system, were taken by surprise. In addition, they perceived the system as unsatisfying, mainly due to stability and performance problems. They were also concerned with the exclusion of secretaries' and nurses' authorization to write a request, which they perceived made their work situation unacceptably time consuming.

As a result, the actor-networks at the clinic became fairly unstable and translations of interests both in favor for and against the system were taking place. Some actors opposed the new actor as an intruder from the outside, sent by the actor "the radiology ward". Other actors were more willing to accept the new actor into the actor-networks at the clinic. The project management tried to push for the enrollment of the new actor into the actor-networks at the clinic. However, as none of the actors were able to achieve order and align the heterogeneous networks, the project management agreed with the director of the clinic to carry on the parallel adoption over the summer.

5.3 Big-bang proposal and rejection

The third de-stabilizing event was 'big-bang proposal and rejection' (see Figure 2) when the project management planned for a hospital wide implementation during the autumn of 2002.

In September 2002, when this became clear to the actor-networks at the clinic, they enrolled actors outside their own clinic, and strongly opposed the plan. They translated their interest to request that further implementation efforts were stopped until the system was improved. Although the perception of the system varied amongst the actors at clinic, there was a shared opinion that the system was too slow and unstable.

The project management recognized the problems with both performance and stability, and was working with improvements, but they were not aware of the magnitude of the perceived shortcomings among the actor-networks at the clinic. As a result, the hospital wide implementation was postponed and efforts were made to identify the main problems related to performance and stability of the system.

At this time the project manager for the 'pilot project initiation' (see Figure 2) had left the hospital and her assignment were considered concluded. Instead, an enthusiast physician at the pilot clinic aligned with the main project manager and the suppliers to improve the system.

5.4 Release of image version

The fourth de-stabilizing event was 'release of image version' (see Figure 2) that became accessible at the clinic in November 2002. The new actor, the order form system, had now been integrated with a standardized web-viewer from the PACS.

The actor-networks at the clinic perceived the new actor as insufficiently slow and unstable as before. Therefore, even though the potential of access to the digital images was recognized, the actors enrolled more actors from the other clinics to oppose the new actor and require further improvements.

5.5 From push to pull

The fifth de-stabilizing event was 'from push to pull' (see Figure 2) that emerged in the process. The enthusiast physician had successfully translated and negotiated the interest of the actor-networks at the clinic that resulted in some changes in functionality (e.g. the authorization issue), user interface and an alternative access point to the system directly from the hospital intranet.

As a result, the approach had turned from the original push from the project management to pull from the actor-networks at the clinics with demands on functionality, user interface and improved performance and stability.

The heterogeneous networks were more stable with aligned interests, to improve the order form system to become a sufficient actor in the actor-networks. I.e. the new actor, the order form system, was enrolled into the actor-networks at the clinics, although with continuous demands on improvements.

5.6 Substituting supplier

The sixth de-stabilizing event was 'substituting supplier' (see Figure 2). The system was released hospital wide in March 2003. At this time the problem of performance and stability remained, but the heterogeneous networks at the clinics were aligned in the interests to enrolling the new actor.

At this point, the project management and the supplier disagreed about the responsibilities for the insufficiencies of the system. After more than a year of efforts to identifying and attempts to correcting the problems without succeeding, this collaboration was finalized at the end of 2003. Instead, the project management engaged a new supplier in February 2004 that was rebuilding the system using the old system as requirements specifications as an effort to solve the problems of performance and stability.

5.7 Overall ICT-based Change

The selected de-stabilizing events helped us understand the overall process of translations and negotiations that subsequently took place as the actors and their interests shifted over time. The actor-networks at the clinics involved in the paper-based information processing of radiology examinations were stable heterogeneous networks with aligned interests. The networks behind the radiology examinations could, before the de-stabilizing events, be black boxed or punctualised into a single actor. However, from the first de-stabilizing

event, the 'pilot project initiation' (see Figure 2) and onwards, various actor-networks translated and negotiated their interests in a continuous process.

Within the clinics actor-networks of allied nurses and secretaries acted proactively from the start in their translations of interests, while the physicians acted more reactively at first. However, this changed as the physicians were confronted with the new actor and the inscribed translations, which assigned them as main users single-handed. The enthusiast physician allied with the project management and enrolled the physicians to become more proactive in the process and translate their interest to improve the system in line with their needs and preferences. Consequently, the nurses and secretaries became less influential in shaping the resulting change.

All through the de-stabilizing events the importance of high performance and stability of an actor is indicated in the actor-networks in this environment. The hospital environment shows no liberation towards any change that would consume more time than before. However, the events also indicate the relation between various professions and tasks related to perceived time consumption. The analyses of these de-stabilizing events show how implementation of the new actor implied a shift from tasks previously performed by other professions (nurses, secretaries, archive personnel etc) to physicians instead.

6. Discussion

Our research focuses on how de-stabilizing events can be used to structure and report from ANT studies of ICT-based changes. More specifically we asked what the advantages and disadvantages of such an approach would be and whether it helps manage the veritable mass of details that ANT studies offer.

The key advantage of adopting de-stabilizing events as a structuring mechanism is that it requires the researcher to interpret the overall change process and make an appropriate selection of important areas of interest. The approach is in this way one possible response to the difficulties of selection from the mass of details for presentational purposes (Walsham, 1997). Walsham points out that ANT emphasizes details and implies that the problem seems magnified, but he also recognizes that complexity problems are real and needs to be addressed. We found that the pre-selection of de-stabilizing events guided us to subsets of the mass of details collected. At the same time, this approach provided support to direct the analysis towards certain dynamics of the actor-networks involved in the change process. We found, metaphorically speaking, that the selection of de-stabilizing events became a useful approach to 'scaffolding' our analysis. From the conduct of the analytical experiment we also found that the selection of the de-stabilizing events helped construct a chronological order that led to a strict and succinct analysis well suited for situations in which presentational space is limited.

The flip side of this is that the consequential reduction of the process can lead to ignoring subtle changes taking place continuously in the process.

The destabilizing events are, of course, chosen based on the researchers' interpretation of which events in the process best illustrate the change process. In that way, they become a means for emphasizing important dynamics. However, the danger of the approach needs to be stressed. Selecting certain events while deliberately keeping quiet about others, can, of course, be misused in careful tactics to craft a desired conclusion, as a way of captation (Latour, 1987), referring to the skilful truth maker anticipating the reader's objections and controlling the reader's possible sense making.

It is not straightforward to relate the proposed approach to other approaches (networks-centric, actor-centric, time-centric and event-centric) since we only have access to the papers and not the complete data set. We have no knowledge of what mass of details is behind each report or what selections were made. The assumption is that there were masses of details, based on the general character of ANT studies, which have undergone selection processes similar to the one described here to suit the authors' choice analysis focus and presentation.

The networks-centric approach focuses on networks. As these constitute the core of ANT, this is no doubt a well-suited approach to structure and present ANT analyses. Nevertheless, the general difficulty of the ANT approach remains: where do these networks begin and end? The approach seems to provide little support to select from the mass of details and report the study. Further, the example report (Walsham & Sahay, 1999), an article of twenty-four pages, seems to indicate that this approach requires a fairly substantial presentational space. In this particular paper, the analysis is structured around the creation, extension and maintenance of the network. As an alternative, one could therefore argue that it represents an event-centric approach, depending on ones emphasis. However, this multiplicity of possible interpretations characterizes most of the reported ANT studies reviewed and it is part of the reason for their richness.

The actor-centric approach focuses on the actors and their translations and negotiations in relation to certain aspects of the networks. In contrast to the network-centric approach, this approach structures the analyses on selected actors rather than the network as a whole. In the same way as the networks-centric approach, no specific support for selecting or structuring data was observed. One of the reviewed papers (Hanseth & Monteiro, 1997) is long, twenty-seven pages and fourteen pages analysis, and even if the other reviewed paper (Bloomfield & Vurdubakis, 1994) is shorter, fourteen pages of which the analysis is about eight pages, which indicate that this approach also requires a fairly substantial presentational space.

The time-centric approach focuses on time as a central principal for structuring analyses. The lack of a stated view on time and temporality in ANT (Kavanagh & Arujo, 1995) makes this an interesting approach. However, no specific support is provided for handling the mass of details. Also, the reviewed papers (Scott & Wagner, 2003; Kavanagh & Arujo, 1995) are fairly long. The first being twenty-five pages long of which the analysis is about 10 pages, and the second is sixteen pages long with about eight pages long analysis.

The event-centric approach focuses on events as a principle for structuring analyses. In the example paper (Holmström & Stalder, 2001), events are used to structure and present the case, and the following analysis offers explanations to the described events. This approach seems the most similar to the proposed approach, with the difference being the particular focus of events. In the event-centric approach, events represent phases or outcomes. De-stabilizing events as proposed in this research refer to events within the process, and not larger phases. The approach also seems to enable the more succinct analysis of the approaches identified with the five pages long analysis in the reviewed paper (Holmström & Stalder, 2001) of seventeen pages.

In addition to the methodological experiences from the experiment with this approach, we learned about the ICT-based change at the hospital. The longitudinal study illustrates the character of an ongoing change process and the impossibility to anticipate all technological or organizational changes ahead of time as pointed out by Orlikowski and Hofman (1997) in their study of groupware technology. Their recognition of the need for improvisational management is highly relevant also here.

7. Contribution of Event-based Approach

The aim of this methodological illustration was not to identify superior ways of structuring and report ANT analyses. We recognize the need for situational considerations for each analysis. The aim was rather to contribute to our understanding of how different approaches to structuring can prove useful. Experiences with process studies in general extend the basis for experimenting with approaches to structure and present ANT analyses. Longitudinal studies are well suited to research organizational change (Pettigrew, 1990), and such studies face the same problem as ANT analyses: process data are generally complex and making sense of them is a constant challenge (Langley, 1999). In structuring the data it is important to reveal temporal interconnectedness (Pettigrew, 1990) and one particular strategy for theorizing from process data is temporal bracketing in which the study is presented in successive periods as a particular approach to structuring the description of events (Langley, 1999). Along these lines, Newman and Robey (1992) have described systems development as a social process of brief encounters between actors and longer periods of stable relationships.

In the particular area of organizational diffusion of technological innovations, Robertson et al. (1996) argue that change can be understood as a series of episodes in which the involved stakeholders iterate decisions related to the new technology. The episodes include (1) agenda formation negotiated between different groups of actors, (2) selection of implementation approaches, (3) implementation supported by organizational adoption and training, and (4) usage of the new technology tailored to the specific circumstances of different groups.

This view of the diffusion process is in line with Weinberg's change model (1997). An ICT-based change process proceeds, according to Weinberg, from an old status quo (established work practices) towards a new status quo (new and hopefully improved work practices) through a number of events: a foreign element arrives (e.g. a project, a prototype, or a system), attempts to reject the element, attempts to accommodate it into old status quo, arrival of a transforming idea, attempts to integrate the foreign element, attempts to practice and master the new way of working, and possibly arrival at a new status quo.

Our methodological illustration builds on these studies and contributes with specific knowledge about ANT analysis of ICT-based organisational change. First, these studies emphasize temporal relatedness as a major principle for overcoming the complexity of longitudinal process data. Our illustrative example apply the principal of chronological order of identified events of longitudinal the process data.

Second, several of the sources emphasize the importance of focusing on events that transform or disrupt the established order: Newman and Robey (1992) focus on encounters that separate the process into periods of stable relationships; Robertson et al. (1996) focus on episodes that change the agenda, lead to decisions on approaches, or involve changes in ways of working; and, Weinberg (1997) emphasizes events that disrupts old status quo and leads to a period of chaos in which events can make the organization revert to old status quo or successfully move towards a new status quo. The use of de-stabilizing events in our methodological illustration illuminate that from an ANT perspective, such events can be all of the above and more, what ever de-stabilizes the actor-networks at focus.

We learned from the suggested approach that de-stabilizing events help select a subset of data and direct the subsequent analysis, and it help create a succinct reporting of an analysis when desired. The chronological order applied supported the structuring of the data analysis. We believe this approach may be useful for other ANT analyses of ICT- based case studies. Further, we suggest that it might be useful to combine the proposed approach with other principles, for example with some of the four identified in the review: networks-centric; actor-centric; time-centric; and event-centric, in future experiments of reporting ANT analyses.

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Work-Integrated Mobile Technology: Towards a Patient-oriented Workplace in Health Care Settings

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***Abstract**: Mobile artefacts are becoming increasingly widespread in many different settings, from business environments to public, as well as everyday life situations. In this study we focus on the emerging use of mobile technology in specific work settings. An elaborated usability framework is proposed as a means to identify certain aspects in mobile IT use. We applied the framework in order to base an empirical study conducted in the health care sector, the central surgery department at a middle-sized, Swedish Hospital. Focus of the study was to start analysing the user's perceived usability towards tablet PCs and to find certain implications for improving the use and handling of it in their specific work environment. The results indicate that the use of tablet PC makes the work more mobile and it is smoothly integrated in the primary caring task. It is also revealed fundamental problems with efficiency and user satisfaction in the direct interaction with the tablet PC itself, as well as the application. We discuss further studies in order to follow the usability research of work-integrated mobile technology.*

***Keywords**: usability, mobility, user-centred, work-integrated, health care, usability framework, tablet PC*

1. Introduction

What do the current usability frameworks for mobile devices offer to identify implications for evaluation and re-design? In 1998, Gosbee (1998) questioned

if a usability professional or researcher can acquire sufficient domain-specific knowledge to efficiently perform a usability evaluation in the health care sector. He presented several research questions to be raised in the domain of health care. Many studies have shown the challenges of identifying an appropriate design methodology for such complex environments (see for example Brown & Motte, 1998; Brown et al 2002). In particular, Ancona et al (2000) investigated several research initiatives aiming at exploiting mobile computers, connected via wireless networks in health care environments where the main focus was on sophisticated solutions for taking clinical information at the point of care.

We will address this question and argue for the insufficiency of current research on usability methods and frameworks for mobile devices. Thus, we will elaborate on a work-integrated usability framework for mobile technologies and provide concrete findings from the application of this framework in a particular work domain, namely a central surgery department. Our main goal is to provide concrete insights as well conceptual understandings of how to design and implement a usability framework for work-integrated mobile technology. We focus on the creation and application of a conceptual usability framework for integrating mobile technologies in specific work settings. Our preliminary findings have been analysed, according to the usability framework, in the work setting of anaesthesia nurses within the surgery department. In the paper we focus on two parts; (i) a conceptual usability framework that we developed as a working tool for the design of an empirical evaluation study, (ii) an empirical study that will provide concrete insights of an evaluation of the perceived usability of tablet PC.

The long term ambition of this work is to guide clinical health care organisations to integrate mobile technology into their working environment, to achieve usable and patient-oriented, mobile workplaces. This is a somewhat top-down goal of the organisation in charge for this study. However, for this research project we identified certain problems related to usability aspects of mobile technology. What are the problems and possibilities of tablet PCs in the context of surgery work and documentation in particular? What role does the division of primary work (care-taking) and secondary work (documentation) play for anaesthesia nurses in their use of mobile tablet PCs? What are the main challenges to have mobile IT smoothly integrated into work situations in general?

Trying to answer these questions, our study ought to be of general interest as it provides a vehicle for considering how mobile devices should be designed to support the work of a particular professional group, such as nurses in health care environments. The study raises profound issues, which bear upon contemporary research in the discipline of Human-Computer Interaction (HCI). It allows us to begin to reveal the intricate and complex usability assumptions, which surround and inform the design and use of mobile devices.

1.1 Related Work

Heath & Luff (2000) present several examples where seemingly innovative and reliable systems have failed when introduced into specific and critical organisational contexts, such as ambulance services and underground systems. In much of these examples the system in question does not necessary cause severe problems, but it is simply "under-used". They call for further examples that actually take the serious account of detailed user studies attempting to exploit the apparent benefits and drawbacks of new technology, in order to find implications for re-design or adopt them.

There are hospitals that have already taken the advantage of the flexibility and speed of wireless networks for mobile IT use (see for example studies by Arshad et al 2002; Levin et al, 2003). Point of care delivery is vital for the success of any application in the clinical healthcare environment. The most obvious issues are those of patient confidentiality and doctor- patient, or nurse - patient relationship (Ancona, 2000; Brown & Motte, 1998). Since patients are in focus, and care-taking often require moving patients around in a clinical environment, mobile technology seems to be an appropriate choice of integrated technology into the care-taking process (Muñoz et al, 2003). However, mobile technologies introduce certain considerations and constraints that have to be dealt with when designing and adopting mobile software application

2. Research Approach

2.1 Research Aim

To have the project goal aligned with the research goal, we will in this paper focus on the potential of using mobile technology (tablet PC) as a means to achieve a more patient-oriented workplace, and how this is achieved at a central surgery department in a middle sized, Swedish hospital. The work is divides in two parts:

(i) Investigate which the crucial aspects of usability are, concerning integration of mobile technology into a given work-context. This part will result in a conceptual (preliminary) usability framework, guiding the design of our following empirical study.

(ii) Conduct a usability and comparative study of a mobile versus a stationary workplace, in this case a Tablet PC (TPC) and a Stationary PC (SPC), focusing on *work-integration* and *mobile* aspects of *usability* found in the first part.

The purpose of the comparative study is, in particular, to evaluate those usability aspects which can be derived from mobility alone, and thereby judge the potential of replacing stationary technology with their mobile counterpart.

Therefore, other factors such as the software used, the users involved, and the environment are kept as constant and similar as possible, so that the technical device should be the only varying factor in the comparison.

In the actual health care organisation the results of the usability and comparative study will be used for two purposes. Firstly, they will use it as input to the clinical decision procedure whether mobile devices should replace existing stationary technology. Secondly, they have the ambition to use it as a starting point of requirement gathering, regarding adoption of the software interfaces for the mobile device.

2.2 Our Approach

The first part of the paper does not aim to propose a fully validated usability framework for mobile settings, but rather to start elaborating upon such a tool. First, we describe related research on different mobile frameworks. Then our particular usability framework is developed as the initiating process of designing the evaluation study. Our approach for this design is built on previous work within the HCI usability field as well as our practical experiences with usability test and evaluation projects. Partly, it is also inspired by the particular evaluation study, in which the pre-knowledge from the initial observations at the central surgery department have influenced the way of designing the proper parameters to evaluate in the next phase. We wanted to clearly identify certain usability aspects that were to be operationalised and verified through our further work. But on a general level, this framework could serve as an appropriate tool for other applications as well. In order to validate its applicability, it would benefit from further development, test and revision in similar empirical studies.

The next part will contain the empirical evaluation study, which we will describe later in the Case Design.

Our approach is user-centred, and usability is our main concern. The authors are experienced with HCI-related researtch projects, education and industry with a particular focus on usability and user-centred design. We are inspired by the user-centred design studies that usually propose that the methodology to be used for understanding users and work situations must take the point of departure from the actual work practice where happenings in the user's real environment can be observed (Heath & Luff, 2000). According to Luff (2000) such a work-oriented approach gives rich information about sequential work flow, physical environment, the users and their interactions, all of which is important. In accordance to these findings, our usability study will be conducted in a naturalistic setting, in a clinical environment at a central surgery department. But before our empirical study we will present our research approach as well as the conceptual understandings we produced during the process of designing the evaluation study in itself, in terms of a proposed usability framework.

2.3 Outline of the Paper

This paper is organized as follows: we start by reviewing some existing models/ frameworks for mobile technology use, and argue why these do not serve our purposes in full. Then we propose an elaborated usability framework for work-integrated mobile technology, which is designed as a tool for user-centred and work-integrated analysis, design and/or evaluation of mobile technology. We will apply our usability framework is applied as an analysis instrument for the empirical case study. The following section introduces the case design concerning usability and comparative study conducted in a middle-sized Swedish hospital. Thereafter we present the actual results and analyses of our empirical study. In the final section we will conclude and discuss the lessons learned from the case study as well as the applicability of our proposed framewor

3. Usability Frameworks and Models

To start our investigation of crucial usability aspects, we review some existing usability and acceptance models and framework, applicable to mobile settings, which may serve our purposes.

Davis (1989) proposes the technology acceptance model (TAM), which identifies the causal relationship between ease of use and perceived usefulness. He claims that greater ease of use leads to higher perceived usefulness, which in turn leads to more usage of technology. The model has been applied in qualitative approaches as well (see for example Bjørn et al (2003)). We agree with this causality, but there need to be a more coherent analysis of what these categories actually consist of, in more detail.

We also recognize the two criteria, *perceived usability* and *actual usability,* as being different aspects of usability, yet interrelated to each other. For instance, perceived efficiency is the users own opinion of how efficient he/she was in completing a task, whereas actual efficiency is the measured time it took for completing the task. The different criteria need different methods of measure, and have their respective benefits and drawbacks, which we will discuss further in connection with the design of our study.

Another framework for mobility has been well developed by Kristoffersen & Ljungberg (2000). They focus on the *use context* as the point of departure for understanding mobile IT use scenarios. The aim of their model is not to define mobility but to provide a framework for the understanding and communication of how people use IT in a mobile setting. The model consists of three main categories, namely *environment, modality*, and *application*. Environment is divided into the sub categories physical and social surrounding. Modality is

instantiated by the different modalities wandering, travelling, and visiting. Application is sub categorised into technology, data and program.

The applicability of this model in our case is apparent. We focus our study on the modality issue, which refers to the fundamental pattern of motion of an activity and indicates the degree of mobility. We also focus on the actual mobile device, and its application, which is used to describe the technical part of the mobile IT use. The interactivity and usability of the application and the actual handle of the technical device itself is of special concern. For example the pen-based interaction and the practical working movements are typical interactivity and usability factors for mobile devices, in particular.

3.1 Limitations in Existing Models

Since our main concern is investigation of *usability aspects* of *integrating* mobile technology into a given *contextual work environment*, we want a framework which explicitly relates to usability. We want a framework which is adapted to a *user-centred* and *work-integrated* approach of analysis. This means, for instance, that users' capabilities and interests are of major concern, and should therefore be included in the framework. Moreover, the contextual parameters need to correspond to all aspects of a working environment, such as the general work situation and process, as well as the particular task or activity supported by the technology, and the environment itself is not enough as the sole unit of analysis. Hence, the above frameworks do not fully serve our purposes.

A work-integrated approach starts from the user's understanding and perceptions about task, work situation, and environment. While having a smooth alignment of the integrative parts environment and work processes, the mobile technology must also be adopted to the actual users and their tasks. Therefore, the intertwined relationships between our usability categories and units of analysis are extremely important when understanding and evaluating work-integrated mobile technology. In particular, we can conclude that the actual modality in Kristoffersen & Ljungberg (2000) is indeed an aspect of the activity that does have influence on the use situation, for example, whilst reading and writing on a mobile device. This is to say that one cannot analyse the different aspects of mobile IT use in isolation from each other (Kristoffersen & Ljungberg (2000).

We found that in a Tablet PC-based work environment the designer has to be more aware of implications of mobile computing and often adapt the usage model of the application to accommodate these. We therefore suggest a new usability framework, which purpose is to support designers and analysts of mobile technology, in their activity of analysing, designing and evaluating work-integrated mobile technology. The framework is used in this study, but need to be tested for generic use in all work-integrated mobile technology settings.

4. Towards a Usability Framework for Work-integrated Mobile Technology

The framework is divided in two major parts: the matrix with the *units of*

Usability Framework for Work-Integrated Mobile Technology

Work-contextual components	**Usability aspects**			
	Mobility	*Ergonomics*	*Efficiency*	*User satisfaction*
Environment				
Work situation/process				
Task technology supports				
Users and other interest groups				

Analysis
Design
Evaluation

Technology
Device
Application
Interaction

We are aware of the impact *technology* has on all work-contextual components, and that this interplay needs an iterative approach. However, we consider herein the particular focus on choice of technology in a cyclic way, through analysis, design, and evaluation. The framework will inspire to identify important aspects and parameters for further analysis. Which these are, depends on case to case. Therefore, the reason to extrude technology from the units of analysis is two-folded:

For designing purposes: in a user-centred, work-oriented approach, the choice and design of technology is the goal of the process, not the input, and ought to be derived from requirements set by the analysis.

For evaluation purposes: the framework is particularly appropriate when evaluating the technological aspect (in contrast to he organisational, or work-process aspect), no matter if the purpose is to compare two design proposals, or to evaluate an existing technology in a given working environment, or as in our case compare two technologies against each other.

4.1 Work-Contextual Components

The work-contextual components, which are units of analysis for contextual assumptions and requirements, consist of the following categories: *Environment*, *Work situation/process*, *Task technology supports*, and *Users and other*

interest groups. In each category, we list a number of areas of interest that are considered for analysis, but to what extent these areas are of major concern, depends on the particular case.

We find it useful to divide the areas of interest into assumptions of the environment which are *static* (constant over some time) or *dynamic* (situation-dependent) in their nature. Static properties can be seen as presumptions to the usability analysis, whereas some aspects of usability may depend on dynamic properties. For instance, the physical room in which an activity is performed may be seen as a static property, whereas the light in the room is dynamic and may vary between use occasions, and the light may affect the readability on a screen.

Environment

In the Environment category, aspects relating to integration into the environment are considered, and the areas of interest are physical, technical and social aspects of the environment. The physical surrounding may be static if the usage is concentrated to a given place (only local mobility), or varying if the activity is performed in many different places. Technical aspects of the environment include other technical equipment, artefacts and systems that the mobile technology should be integrated into, or that affect the task in focus or the users. The social environment includes work-place practices and cultures, and cooperation with colleagues, for instance.

Work situation and process

Areas of interest concerning the overall work situation include overall work load (type of work, number and co-occurrence of activities and tasks), overall mental and cognitive load (for instance stress, shortage of time, critical situations, responsibilities), organisational issues, labour-division and many more, depending on the particular case. A complete work situation is complex by nature, and the task or activity in focus is often just a small part. Therefore, we choose to separate the two, as distinct units of analysis.

Technology-supported task

Areas to consider for adopting technology to the task in question, is for instance, its relative importance compared to other co-existing tasks, the frequency of use, the effect and frequency of disruption, the effect and frequency of interruption, as well as structural and cognitive aspects of the task itself.

Users and other interest groups

Integrating technology includes adopting it to users and other interest groups. Areas that are of interest are users expectations, their experience and knowledge, physical and mental circumstances such as for instance pain, stress, left-handedness, impaired sight. Pain and stress, for instance, may be constant over a period, i.e., static, or particular for an occasion, i.e., dynamic). The success of technology integration highly depends on the users' attitude towards technology, and how the integration is implemented, and these are

therefore areas of interest for the analysis.

4.2 Usability Aspects

The usability aspects of particular interest for integrating mobile technology in a work-context are *mobility*, *ergonomics*, *efficiency,* and *user satisfaction*. Usability is a complex concept, and it is interconnected with *all aspects of the work-context*, from the physical environment of a building to the mental state of a particular user at a particular occasion of use. Thus, usability may depend in various ways on all the contextual aspects described above, which is the motivation of the matrix-setting of our framework. Naturally, not all combinations in the matrix are of equal importance, but this must be decided for each application separately.

Mobility The usefulness of mobility depends on *where* the technology is used: in the office, at travel, in the hospital, outdoor, indoor, anywhere; as well as the actual placement in the room. Mobility can mean travelling globally, or it can mean the freedom to do the work at different places in a room (for instance, for the nurses to be able to do documentation at the bedside of the patient), can be the aspect of mobility which is of importance. The technical environment often set limitations of the mobility, such as where a wireless net is reachable, where a connection with a server is possible, or if other technical equipment are affected by the mobile technology in use - which may be the case in a hospital environment. Mobility may affect the social environment, such as changing work-place practices or stimulating colleague collaboration.

Mobility can change the overall work situation drastically, by allowing for doing tasks at places and at times where it was not possible before (this may have both positive and negative consequences). Mobility may affect the task itself, and it certainly affect the way it is performed since mobile technology have different properties than stationary (interaction techniques for instance). Finally, mobility apparently affect the users, since they also become mobile in situations where they before where stationary.

Ergonomics

Ergonomics is obviously affected by the physical environment, but also by the work situation and the task itself, since with mobile technology the possible physical positions decrease dramatically. This may allow for performing several tasks simultaneously which affect the overall work-situation, and it may affect where and in which position the task itself is performed. Mobility often increases the flexibility for the users to change positions and use it in their desired ways. On the other hand, since the technology is mobile, the risk of bringing it and using it at ergonomically less appropriate places and positions increase as well.

Efficiency

The efficiency of use is affected by the environment, in particular with mobile technology since the flexibility is much greater. Readability on the screen is one example, which is affected by the surrounding light as well as in which position it is held. Another aspect is *where to place* the mobile technology, in situations when it cannot be held (for larger pieces of mobile equipment, that is). The particular work situation may require moving around doing the task, or moving around doing different tasks, or frequent switches between tasks, which all affect the efficiency using mobile technology. The task in question apparently affects the efficiency (required interaction, information need etc.), as well as the users.

User satisfaction

By user satisfaction, we intend the users' subjective view of the total work situation, which can be connected to the use of the mobile technology in question. Thus, it is the *perceived usability* which is measured, such as how useful the users experience the possibility of moving around with the technology, how the mobility affect their overall work situation, how efficient the users experience that they are performing the task (perceived effectiveness), and whether the mobile technology fulfil their expectations, to list some examples.

5. Case Design

The case we are studying is a pilot study of introducing mobile technology in a health care setting. It is performed at the surgery department in a hospital in West Sweden. The work environment at the central surgery department can be characterised as highly complex, and time- as well as safety-critical. Several medical personnel is undertaking time-critical tasks under physical and emotional stress. In particular, anaesthesia nurses at a surgery department have certain common work conditions. In a busy medical practice, they see several patients per hour and make hundreds of small decisions during a workday. They often perform their procedures with incomplete information. Many nurses are sleep deprived or have work shifts much longer than eight hours. Many varied training levels and licensure restrictions decrease flexibility in reassigning tasks. The documentation work is time-consuming as their attention is on the patient and caring task. Furthermore, there are sterile fields strictly prohibited to entry, and critical situations may appear. Such working environments require extraordinary demands on any technical equipment, even for equipment used for less safe-critical activities (such as documentation of patient records), to effectively support the users in their main activity – care-taking.

The task in focus for this study is the patient recording documentation, which is an important part of a hospital's operational activities, due to patient security,

communication between personnel, planning and organization, and it is regulated by law. Yet, the care taking of patients are always the primary task at all time, which means that the more secondary documentation task has to be performed whenever allowed, between care-taking activities.

Today, most of the patient recording is computerized at the department, however at stationary bases. There are stationary computers in all surgery rooms, and at other strategic places. However, surgery patients are not stationary; they need to be moved around. The aim is to achieve a complete workplace *physically close* to the patient at all time, where all activities care taking, information retrieval, documentation can be performed. This calls for a mobile device for documentation activities, and thus, a pilot study testing Tablet PC as a documentation device is being performed.

5.1 The study

Since the aim is to judge the potential of a mobile device allowing for a mobile workplace, the study will be of comparative nature. The focus is usability. The mobile device (the Tablet PC) is compared with the stationary device (a PC), and other parameters are kept as constant as possible. The same application for documentation is used on the two devices, two similar surgery rooms are used for the test, and the same user group tests the two systems.

The choice of user group is the anesthetic nurses, whose task is to control the level of consciousness of the patient during surgery, as well as documenting the complete course of events, in anesthetic perspective.

5.2 Technical background

Wireless local area networks (WLAN) were introduced at the hospital in 2001. The vision from the organisational point of view is to have all departments that use the general patient recording system based on WLAN technology. There are several advantages of using WLAN, for example it is cheaper if the current network will be extended one must not invest in more physical cables. However, the most obvious and useful advantage is the increased mobility of use. Among the disadvantages there are examples of both batteries' lifetime, transmission disturbance, and of course, the security issue.

The operating system now running on the stationary computers is Windows2000 and the one running on the mobile tablet PCs is Windows XP. The particular application used in this study is Orbit, which is a patient registration application program for registering the patient's arrival, who the responsible nurse was, eventual complications during the caring visit, arrival and department time to have the care time in total etc. Orbit is also used to document the various work plans, procedures and performance. There are various registration, navigation and search possibilities. The planned operations and their process and status can be read from the system. An overview of different patient operations and types can be presented as well as the daily and monthly prognosis and follow-

ups.

The mobile device used in this study is a HP Compaq tablet PC TC1000. It is equipped with an electro-magnetic pen as one specific input device, for both pointing and writing. It is a pen-based interaction where one can use the pen and a touch screen when to have hand-written text and to select from menus. The system is using a hand-writing recognition software. The system is also provided by a virtual keyboard, which lets the user to select the letters through key pressing actions.

The stationary PC is a HP Compaq Evo, equipped with a keyboard and mouse as input devices, and a 17' monitor screen as output device.

6. Method

Our approach is user-centred and context-based, and we use the method of Contextual Inquire, meaning that all our tests, observations, interviews, and inquires are conducted in the proper context, and with the actual users of the system (see for example Preece et al, 2002).

We started out by doing a pre-study outsider observation, to observe the environment, the work situation, potential problems with the task and to get an overall understanding of the users' situation.

Following the observation, interviews with primary users, organizational and technical personnel were conducted to collect further information regarding the user group, technical and safety issues as well as organizational issues.

Our usability framework was used to analyse the information, and help us to identify the relevant comparison parameters. To be able to do a comparative study, it is needed to identify which parameters that varies, and which ones of those that are possible and interesting to measure.

The main data-collection method used is a reaction study, which is a particular kind of inquiry method. It should be performed repeatedly during a period of time, and answered directly after a performed task, as a reaction on the performance. The questions should be formulated so a reactive answered is possible, and should not require deep considerations. The purpose of such a study is to collect data which is close to spontaneous reactions from the users.

In our case we use questionnaires which are filled-in by documenting nurses after each surgery, during a period of two months. The number of participants in the study is 10 anaesthesia nurses, randomly chosen from the user group. The participant group includes both female and male participants, as well as right- and left-handed. The study is performed in two similar surgery room, placed next to each other.

Using questionnaires that the users fill-in, implies that we measure perceived

usability rather than actual usability, since we measure what they say they do and instead of measuring what they do (by logging the activities on the computer, for instance). The reason we choose a reaction study is two-folded: First, it is a method that requires less time spent by the users than most other enquiry methods, since it is designed to be fast to answer. Our user group have a heavy work load as it is, and we want to reduce the time required for them. Secondly, even thought the reaction study measures perceived usability, since answers are direct reactions on what just has happened, they are likely to be close to what did happened. Compared to letting the users summerize their experience during a period of time, where unusual and later occurrences tend to get to0 much weight and importance.

To minimize the required time for the reaction questionnaires, a pre-study questionnaire was designed containing aspects that were not expected to vary from time to time, and filled-in by the participants once before the reaction study.

To collect information concerning user satisfaction, as well as getting a better understanding of the reasons behind the findings in the reaction study; post-study, qualitative interviews with the participants will be conducted.

6.1 Data analysis

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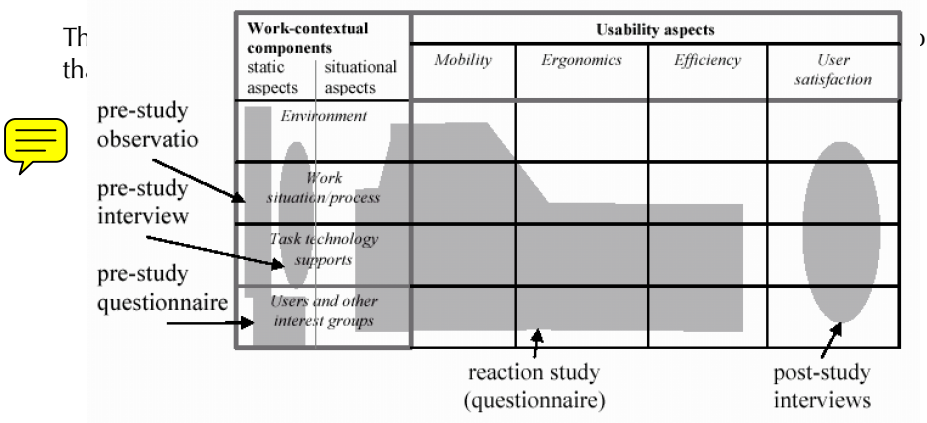

Our investigation of relevant parameters for analysis for the different work-contextual components, i.e., parameters *that differs* for the tablet/mobile PC and the stationary PC, resulted in the following operationalisation:

Environment:
Light circumstances in the surgery room (some surgery require dark) Placement in room (where the documentation take place)

Work situation:
Length of working shift Complications during surgery Longer absences (lunch etc.), changing shifts

Task:
Length of surgery, when the documentation work was performed

Physical position during documentation work (sitting, standing holding device, standing device laying on surface)

Frequency of interruptions (how often the documentation work is interrupted to attend to other tasks)

Frequency of disruptions due to technical problems, or disturbances Symptoms of fatigue or pain due to computer use

Use efficiency:
Readability (smaller screen on tablet PC, different position reflexes from light etc)

Interaction: input (different input devices: mouse-pen, keyboard-virtual keyboard)

Interaction: navigation

Users:
Professional experience and experience with computerized documentation work,

Their physical and mental condition normally (left- or right handed, tiredness, pain)

Attitude towards computerized documentation in general and the tablet PC in par

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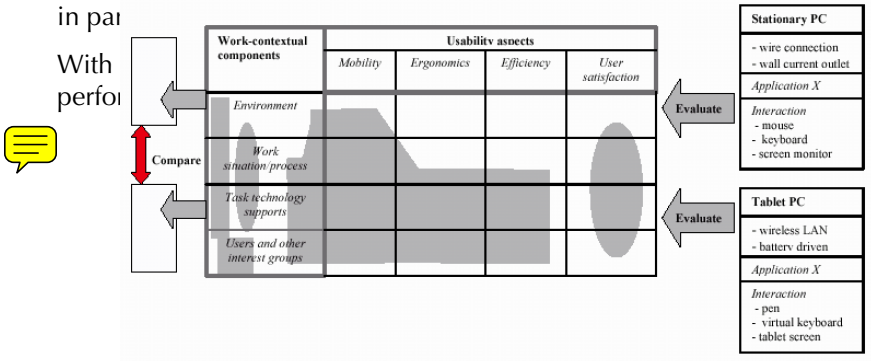


7. Case Results

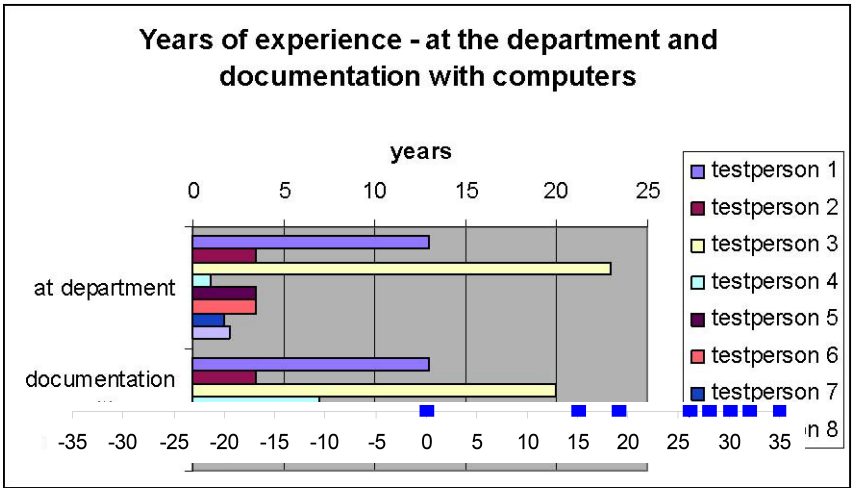
The reaction study was conducted with 10 randomly chosen anaesthetics nurses, during a period of two months. The test persons started out to fill in a pre-study questionnaire, containing questions concerning their experience and normal situation. After that, they were asked to fill in the reaction questionnaire after each surgery they attended, for at least four days in each of the surgery rooms involved in the test, in which one had the stationary PC and the other one the Tablet PC as documentation tool. Since the length of a surgery can vary between 5 minutes and many hours, the number of filled-in questionnaires varied for different test persons between 5 and 15 for each station.

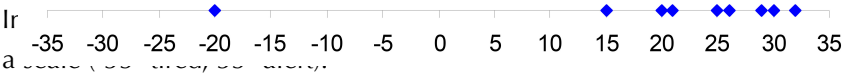
Unfortunately, one of the test persons had a longer period of sick leave, and could therefore not finish the study, and one test person had only one session with the Tablet PC and was therefore omitted from the statistics Tablet PC dependent statistics. Thus, we have results from 9 test persons for some of the questions, and only 8 from the once depending on the usage of the Tablet PC.

The questions in the questionnaires were the same for both technologies, but there were a couple of additional questions for the Tablet PC concerning *where in the room*, and *in which position* (i.e., sitting, standing, etc.) the documentation work was performed.

In total there were 142 filled-in questionnaires, of which 60 was with the Tablet PC and 82 with the stationary PC.

Users:
Of the 9 test persons, 3 are left-handed and 6 are right-handed. There were both very experienced nurses, and some with less experience: in average they had 7,47 years of experience of working at the department and 6,5 years of experience documenting on computers (see the table below):



Ir 

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and rather calm: in average 19,8 on a scale (-35=stressed, 35=calm):

*Comment: Attitude towards computerized documentation in general was rather positive among the test persons, except for the double work they had to do (documenting parts both on paper and on the computer) and most of them had too little experience with the Tablet PC to have a clear opinion of it yet.

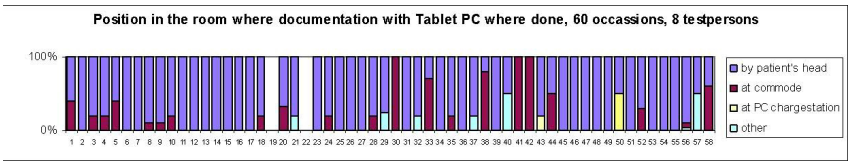
***Environment**:*
Light circumstances in total: sun 2%, day 43%, ceiling 70%, light 5%, dark 35%, other 8%

Light circumstances TPC: sun 1,9%, day 42%, ceiling 73%, light 5,8%, dark 36%, other 9,6%

Light circumstances SPC: sun 1%, day 44%, ceiling 68%, light 4%, dark 35%, other 4%

*Comment: Varies, but about the same both SPC and TPC.

Places in the room: by patient's head 79,86%, at commode 15,5%, at PC charging station 1,25%, other 3,39%

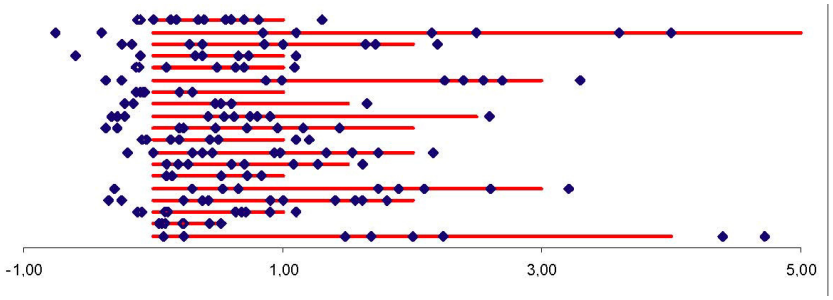


*Comment: The users choose – to a great extent – to be close to the patient's head if possible (not possible with stationary PC due to lack of space). Thus, the local mobility of the Tablet PC is indeed utilized. Moreover, the possibility to work in different positions when using the mobile PC, is utilized to a large extent as well.

Work situation:
Length of working shift: --- up to 8 hours previous shift Complications during surgery:

No impact on documentation work: totalt 7(142), TPC 2, SPC 5 Impact on documentation work: totalt 9(142), TPC 7, SPC 2 Apparature: 2(142), dvs. 1,4%, both on SPC!

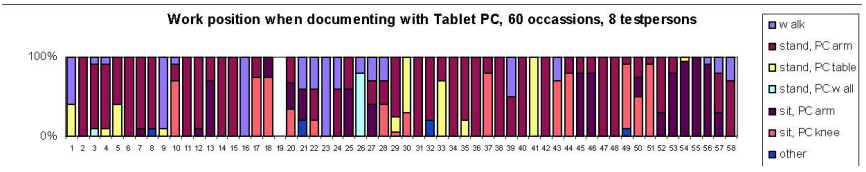
Task:
Length of surgery, when the documentation work was performed: examples from distribution of documentation (different test persons, both TPC and SPC). It is performed pre-surgery, during surgery, and post-surgery (the line denotes the duration of the surgery, the dots the occasions where documentation was performed).



*Comment: The task of documentation is a highly integrated, distributed activity and has low priority compared to care-taking activities. The activity is scattered over time, and performed whenever possible.

Physical position during documentation work: (sitting, standing holding device, standing device laying on surface)

Physical work position: gå 12,63%, stå1 48,21%, stå2 6,75%, stå3 1,58%, sit1: 15,75%, sit2 14,02%, annan 1,05%

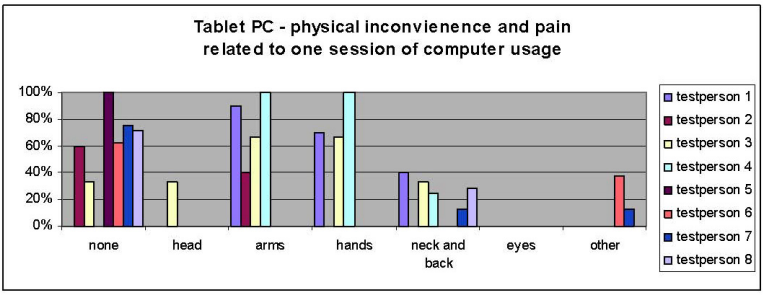


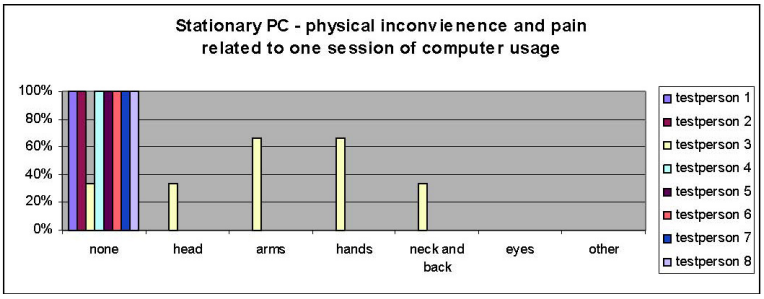
Frequency of interruptions (how often the documentation work is interrupted to attend to other tasks): see distribution of documentation above.

Frequency of disruptions due to technical problems, or disturbances: see above

Symptoms of fatigue or pain due to computer use:

Totalt: inga 82%, huv 1%, arm 12%, hand 9%, rygg 6%, ögon 0%, annan 3%
TPC: inga 60%, huv 0%, arm 26%, hand 19%, rygg 14%, ögon 0%, annan 7%
SPC: inga 98%, huv 1%, arm 2%, hand 2%, rygg 1%, ögon 0%, annan 0%





*Comment: Physical problems and fatigue: clear difference – TPC is too heavy according to many users, resulting in fatigue and pain in mainly arms and hands. Need to be addressed. For instance, no practical place to put the tablet PC (can probably be arranged). This will be analysed during post-study interviews. No clear correlation between fatigue and later parts of the working shift.

Use efficiency:
Readability (smaller screen on tablet PC, different position reflexes from light etc)

Problems reading screen:

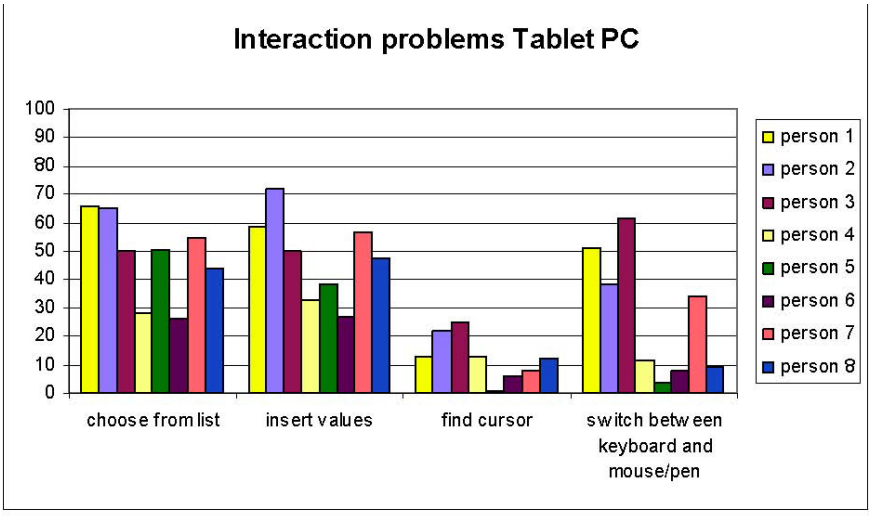
Totalt: 90% 123(142) inga, 10% problem
TPC: 70% 41(58) inga, text 7%, symb 7%, reflexer 16%, ljust 2%, other 2%
SPC: 100% 82(82) inga

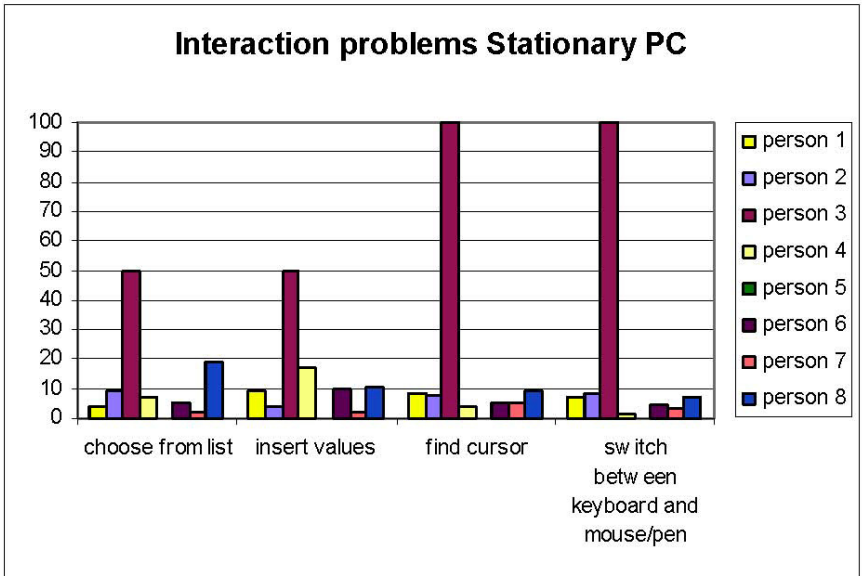
*Comment: Readability – no one had problems with SPC, some with TPC. No clear correlation between light condition in the room and readability problems.

Interaction: input (different input devices: mouse-pen, keyboard-virtual keyboard)

Problems input:

Totalt: val ur 23,9, inmatn 23,99, hitta markör 9,37, växla 13,77
TPC: val ur 46,5, inmatn 45,53, hitta markör 10,4, växla 22,45
SPC: val ur 7,48, inmatn 8,32, hitta markör 8,73, växla 7,52





*Comment: Interaction problems – clear different between SPC and TPC, only one person problem with SPC, quiet a lot with TPC. Possible reasons: less experience with pen and virtual keyboard, but could not see any downward trend by gained experience (could be too early to say). More plausible reason: the interface is not adopted to optimize the different interaction techniques used by TPC – need to be adopted. We expected that there could have been a difference between left- and righ handed people (most interfaces are designed so that the control mechanism is to the right of the information to control, which may be problematic for left-handed pen-users. However, we could not see any significant difference – the interaction problems varied by individuals, but not clearly in favour for right-handed people.

8. Conclusion and Further Work

This paper has discussed the fundamental issues to be considered in the creation and application of a conceptual usability framework for integrating mobile technologies in specific work settings. We have elaborated on a usability approach to be applied in the specific setting of the surgery department at a hospital in west Sweden, in order to finalise the usability and comparative study of mobile devices in such setting. Our preliminary findings from the usability test are analysed in parallel with the development and refinement of the suggested usability framework. Our findings relates to both the applicability of the framework as well as the provision of the concrete insights of the study.

Firstly, our results reveal implications about the *mobility* aspect of health care documentation. The documentation work is to a large extent going mobile by the use of the tablet PC. The local mobility is highly utilised when nurses are documenting their work. They do utilise the mobility of the tablet PC and apply several working position such as standing and sitting by the patient's head.

Secondly, the *work-integrated* aspect of mobile IT use can be read. The documentation task itself is being distributed and scattered over time, which means that the interplay between their primary task of care-taking and their secondary task of documentation is extremely fluent. The distributed nature of the documentation task implies that it is integrated into the existing practice of care-taking. Their attention can to a large extent be paid to the patient, during and in between their documentation work. That is to say that mobile technology partly is being work-integrated, where the interplay between the primary and secondary tasks can occur in places where their attention is determined by the primary focus, i.e. the patient.

Thirdly, we can conclude fundamental problems with *efficiency* and *user satisfaction* in the interaction with the computer and application. We cannot see any changes over time, due to their learning of the system. The main problems concerned the input devices and the input styles used for interacting with fill-in forms. We conclude that these problems are related to the incompatibility of the application which is not adapted to mobile use. We recommend to further consider the particular challenge of mobility when interaction with the application.

We realise that our results make it difficult to predict the real usability of mobile devices. At least we can conclude, while our findings could be the perceived rather than the actual usability, it gives us a starting point, and allows us to see deviations and directions for further work. The current results need to be further analysed for its purpose. To gain further insights of work-integrated mobile technology we will conduct the following post-study interviews, in which to get an in-depth understanding of work practice, environment and interactions, based on qualitative, semi-structured methods. This will help us to develop our understandings as well as our proposed usability framework, which can then be further refined and tested in other settings.

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